Vol. IV MARCH, 1933 No. 1

CHILD DEVELOPMENT

In this number there are reports of variability in weight and height of children; of social development in infancy and of children's usé of money; of motor learning, visual fixation, and the efficacy of distractions; and the application of Descourdes Tests.

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CHILD DEVELOPMENT

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CHILD DEVELOPMENT

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Sustained Visual Fixation of Preschool Children to a Delayed Stimulus

KATHERINE A. MILES[1]

THE literature in the field of child development offers comparatively few studies bearing on the problem of the measurement of sustained attention in children. Investigations of introversion-extroversion and occupational interests of children have furnished some general information about the length of time a child will attend in a natural situation. The only study which has utilized a purely experimental procedure is that of Brown (1) who uses the continuous reaction method in attention as measured by efficiency in performing a simple motor act. Her results indicate that attention tends to improve during the course of the experiment, that original fixation on one or more of the details gradually shifts to apprehension and control of all the elements involved, and that I.Q. correlates fairly well with either best or final performances but not appreciably with any other measures.

The purpose of the present study is to determine the length of time preschool children will maintain visual fixation upon a delayed stimulus, the relationship between intelligence and visual attention, between age and length of visual regard, and lastly the existence of sex differences in this type of visual response.

The method of delayed stimulation was used to measure the length of time a child would maintain a fixed gaze upon an object. It was assumed that this also furnished an indirect measure of sustained attention. If by attention we mean the degree of the sensorimotor adjustment of the organism with respect to a particular stimulus, such an assumption is warranted.

The total experimental group was composed of 58 preschool children from the nursery school and kindergarten of the Institute of Child Welfare, University of Minnesota, ranging in age from two years six months to six years three months. There were ten 3-year-olds, eight 4-year-olds, twenty-four 5-year-olds and sixteen 6-year-olds. At each age the subjects are equally divided in respect to sex except in the two year group. The mean I.Q. of the group is 108 and the I.Q. range is from 79 to 135. Only nine children have I.Q.'s below 100 and only one child below 80.

The delayed stimulation experiment was presented twice to each child; this allowed for computation of reliability

[1] From the Institute of Child Welfare, University of Minnesota.

by the test-retest method. A jack-in-the-box technique was employed to furnish an experimental situation which would be intrinsically interesting to the child. Three identical wooden boxes 5 inches square were used in both the original test and retest series. Their contents varied in each series. In the first test a small china doll attractively dressed, a red rose with stems and leaves, and a clown wearing a tall hat which would fold up when compressed into the box, were used; in the retest a colorful wax apple, a flat valentine clown face, and a small rubber dog whose tongue and tail both appeared when he was squeezed. Each object was mounted on a coil spring which was invisible to the child.

The boxes closed with an ordinary hook fastening to which was attached a long cord. The experimenter could thus operate the boxes with a minimum of distraction to the subject. Each box was weighted to assure a stationary position throughout the experiment.

A white screen 29½ x 20 inches was placed so as to divide the small table at which the child was seated, leaving about 1½ feet of table surface in front. It served as a constant background for the child's fixation, and also as a screen for the boxes that were not in use. A stop-watch and record blanks constituted the remainder of the material used in this experiment.

The general procedure was to seat the child at a small table and tell him we were to play a "watching game" which was really very easy for all that had to be done was to watch carefully the various things which would be shown him. As soon as his interest and coöperation were aroused formal directions were given as follows:

"I am going to show you a box which has something in it you will like to see. When I put the box in front of you it won't open right away. Sometimes it will take the box a long time to open and sometimes it will open real soon. You never know when the box is going to open. Now Jane the way you play this game is to watch the box very carefully so you will be looking right at it when it does open. Do you understand? Are you ready for the first box? Remember and watch carefully for the box to open."

The 3 boxes were arbitrarily numbered and presented in a predetermined order as follows: 3, 1, 3, 1*, 3, 2, 2*, 1, 2, 3*, 1, 2. The starred numbers indicate a counter method adopted after the first thirteen children had received their first trial. Its purpose was to counteract the tendency of children who perceived the method and purposefully looked away in order to shorten their task. At these points in the series the box was opened only when the subjects were looking directly at the box. Records of these presentations were not used in computing results. Thus records of only nine of the twelve presentations constituted a trial.

Upon the completion of formal directions the first box in the series was presented in the middle of the table surface before the child. As the child first fixated his eyes on the box a stop-watch was started. It was stopped at the first shift of visual regard. Simultaneously with the stopping of the

watch, the experimenter pulled the cord, which extended well over the edge of the table, thus releasing the 'jack.' The child usually examined and remarked about it.

The duration of visual fixation was immediately recorded. Then the second box in the series was similarly presented with, "Here is the next box. Remember and watch carefully for it to open." This same procedure was followed throughout the entire series.

If the child showed a desire to introduce a guessing element into the game by such remarks as, "I bet I know what is coming next—the dog.", minor additions were made to the directions to capitalize on this interest such as, "Let's see if you are a good guesser." or "Watch carefully to see if you are right."

The interval between the first test and the retest was more variable than is desirable. Thirteen subjects who had their first trial the latter part of November did not take their second trial until approximately two months later. For the remainder of the group the interval ranged from a minimum of ten days to a maximum of thirty days.

CONSISTENCY OF RECORDING

In order to determine the consistency of recording, three observers, watching at different times, observed a total of seven children through one series. On 28.4 per cent of the time records the second observer agreed perfectly. During the total of 1525.6 seconds when another observer was present, a difference of 39.7 seconds was found between their records and those of the experimenter. The percentage disagreement is therefore only 2.6. This shows high accuracy in the recording.

RELIABILITY

Reliability was computed separately for three age groups, three and four years combined, five years and six years individually. The coefficients were respectively .62 $\pm$.10, 59 $\pm$.09 and .83 $\pm$.08. Since the scores of the children were obtained by averaging both test and retest the Spearman-Brown formula may be applied to these coefficients. This raises them to .76, .74 and .90 respectively.

POSITION IN THE SERIES

The influence of the position in the series on the time score of the boxes was analyzed to determine if the procedure of using a composite average time score for the first trial and for the retest was justifiable. The first, middle and last boxes were chosen as representative of each series. The total time scores on each box individually showed that in the original test the first box is fixated approximately one minute less than the middle box and two minutes, 57.2 seconds more than the last box. The middle box has the highest time score. In the retest, the middle box again exceeds the others, the first box having been fixated 57.4 seconds less than the middle one and 5.11 seconds less than the final box. These differences were found to be statistically non-significant.

AGE DIFFERENCES

There is a distinct differentiation for the different age groups in respect to the mean fixation time. The mean for the 3 year group and for the 4 year

group is 8 seconds; for the 5 year 16.8 seconds; for the 6 year group 27.5 seconds. (See Table 1.) The two younger age groups are approximately identical in the length of time they maintained visual fixation on a delayed stimulus. A distinct break however occurs between the four year and the five year age group. The difference between the 5 and 6 year group does not quite reach the critical ratio for

respectively and was so fatigued after the above mentioned very long fixation that the experiment could not be completed. Her results are not included in the group results. In the early part of this long period of fixation there was much motor activity but this gradually diminished leaving the child in a dazed condition.

The r between age and length of visual fixation in this situation was

TABLE 1

Relation of fixation time and age

AGE GROUP	NUMBER	MEAN	DIFFERENCE IN MEAN	DIFFERENCE/σ OF DIFFERENCE
		seconds		
5:6–6:6	16	27.5		10.68/6.82 = 1.565
4:6–5:5	24	16.8	10.68	8.8 /3.147 = 2.796
3:6–4:5	8	8.0	8.8	
2:6–3:5	10	8.0	0	

TABLE 2

Relation of sex and fixation time

AGE	SEX	NUMBER	MEAN	MEAN DIFFERENCE	DIFFERENCE/σ DIFFERENCE
4:6–6:6	Girls	20	25.6	7.4	7.4/6.0 = 1.23
	Boys	20	18.2		
2:6–4:5	Girls	10	5.8	.4	.4/.913 = .44
	Boys	8	6.2		

statistical significance, but that between the 4 and the 5 year groups approximates it closely.

There is 1 individual case which warrants mention. A girl in the 5-year group had the highest individual fixation score in the total experimental group; it was 16 minutes 57.6 seconds duration for a single presentation in the second trial. For two previous presentations she had attended for 4 minutes and 3 minutes 59 seconds

.501 $\pm$.06, indicating the existence of a fairly high degree of relationship between these two factors. However this apparent relationship might be produced largely by a closely related third variable of intelligence. The partial r between age and fixation time with I.Q. held constant was .518, which is only a slight increase over the raw r thus indicating the influence of the factor of intelligence is very slight indeed.

SEX DIFFERENCE

Sex differences in relation to length of fixation were not outstanding. In order to enlarge the groups and because of the marked differentiation indicated in mean fixation time between the four year and the five year group the subjects were divided into two age groups: 2 years and 6 months to 4 years and 5 months and 4 years 6 months to 6 years 6 months. (See table 2.) This afforded somewhat of of an experimental control of age. There were 20 boys and 20 girls in the latter group, and 8 boys and 10 girls in the former group.

In the older group the difference is 7.4 seconds in favor of the girls. As the sex difference is only 1.233 its standard error significance is doubtful. The sex differentiation is much less pronounced in the younger age group than in the older, the difference being .438 the standard error of the difference.

INTELLIGENCE

A Pearsonian correlation was computed between intelligence and fixation time. This was +.294 with a probable error of ±.0809. In this instance the P.E. is so high that it invalidates the slight significance which this low correlation coefficient might have. If any relationship exists between intelligence and fixation time it would only be a very slight positive relationship. By partialling out age the coefficient of correlation between intelligence and fixation time is raised to .328. This does not increase its significance sufficiently to indicate the existence of a marked relationship; rather again a definite low positive relationship is shown.

The close relationship commonly thought to exist between intelligence and attention is not verified by results from this study. Rather one must conclude that there is only a very slight relationship existent between a general attentive factor and intelligence (contrary to all dictums of the past) or that the highly intelligent child will vary decidedly in the attentiveness of his behavior according to the nature of situation in which he is placed. The latter explanation seems more plausible and indicates that the term attention, is merely a descriptive category of behavior. There is little evidence as yet on this problem.

SUMMARY

The delayed stimulus method has decided possibilities for the measurement of sustained attention in preschool children from the standpoint of the objectivity of the recording, the reliability of the test, and the ease of administering it. The application of this test to 58 preschool children between the ages of $3\frac{1}{2}$–$6\frac{1}{2}$ years suggests that visual attention is brief at the third and fourth year levels and increases markedly at five and six years. Sex differences are negligible, the differences within a single sex being much greater than the difference between sexes. The length of visual attention is apparently unrelated to intelligence, but is closely related to age.

REFERENCE

(1) BROWN, M.: Continuous reaction as a measure of attention. Child Development, 1930, 1, 255–292.

Motor Learning of Children in Hand and Eye Coördination With Introduction of Prismatic Deflection[1]

ELINOR LEE BEEBE

INTRODUCTION

THE controlled aiming test as herein described offers opportunity for analytical study of factors involved in hand and eye coördination. It presents a method for using angular deflection in experimentation with young children. Such experimentation gives promise of a contribution toward the solution of that group of problems centered in the Stratton experiment and its recent repetition. Obviously the reaction of the child, who lacks knowledge and understanding of the principles involved and the course of the processes of modification, can provide needed additional data. Ewert (1) states that "the dominancy of receptors in a given environmental situation is greatly influenced by the instruction stimulus. The human being is able to develop a consistent response to either a visual, tactile, kinesthetic, or an auditory stimulus (depending in each case upon the instruction stimulus), inhibiting the sense data from those receptors which may serve as distractors." This observation points to the value of an approach such as is provided in the more nearly naïve reaction of the child.

[1] This report is part of a dissertation presented in conformity with the requirements for the Degree of Doctor of Philosophy at The Johns Hopkins University. The work was made possible by a National Scholarship in Child Development 1928–30, from the Committee on Child Development of the National Research Council.

HISTORICAL DEVELOPMENT

No report of the combination of an aiming or target test with the principle of prismatic deflection is found in the literature. However, localization of objects as viewed through a prism eyepiece is reported. No record of the use of prismatic deflection in experimentation with children has been discovered.

Helmholtz (2) describes the error to right which occurs with prismatic deflection of the field of vision to the right. He calls attention to the process of learning correct localization in successive trials and to the opposite error occurring immediately upon removal of the prism eyepiece. Sanford (4) describes a similar experiment.

Stratton's (5, 6) classical experiment on vision without inversion, though a drastic application on the vertical axis, was worked out on the same learning principles.

Wooster (8), made investigations to study factors involved in the development of a new spatial coördination. A pair of optical prisms was used. Presumably without knowledge of extent or direction of distortion, the subjects decreased the original error 59 per cent.

Conclusions from Wooster's experimentation are in accord with Stratton's results. "No readjustment to the changed visual situation occurred without definite reaching movements of the hand while the eye was fixed on the visual object."

Wooster (8) formulates the hypothesis that "part of the readjustment which occurred was not a reorganization of response with respect to actual position of the object, but represented an adaptation to particular sensory conditions induced by the wearing of prisms." She states that "it is reasonable to suppose that the readjustment in the standard series was due to the tendency of the subject mechanically to react with the hand in response to the old habitual concept of 'front' associated with head position, rather than to the new definition of 'front' involved in the altered position of the eyes in the head. If so, this would indicate that when there is even a slight disturbance of the customary relationship between ocular-motor habits and general bodily habits, the individual mechanically and unconsiously varies his reactions in such a way as to bring the latter into harmony with the established type of reaction."

Loemker (3) attempted to test the Wooster hypothesis as to habitual tendency to react to "front" as determined by head position rather than eye position. No prisms are used; an eyepiece is made of 2 short tubes, each having a perpendicular slit. Horizontal adjustment of this slit changes the relation of the axis of the head and of the eyes from coincidence to divergence to right or to left. This device presents a head-eye relationship to a visual object just contrary to that imposed by prismatic deflection.

All Loemker's subjects showed a marked constant error. When the head was to the right of the eye axis, the error was to the right and *vice versa*. His results support the hypothesis advanced by Wooster. Loemker makes the statement that size and also direction of localization error are dependent "upon the coördinations of the individual developed upon his ocular peculiarities."

Ewert (1), in a repetition of Stratton's experiment, has secured quantitative evidence as a basis for the following conclusions:

"1. In all forms of activity where overt localizing are present there is rapid adjustment to the distracting visual interference.

"2. In most of the experiments the newly acquired behavior during visual inversion did not persist in measurable form upon removal of the lenses.

"3. Behavior from stimulation of more than one receptor is a resultant response initiated reciprocally by the various receptors involved, vision usually taking precedence.

"4. Constant interference during visual disorientation does not prevent steady growth of a habit.

"5. The eyes are readily educable to new compensatory reflexes."

THE EXPERIMENTAL GROUP

Eight nursery school children, 4 boys and 4 girls, are used as reactors.

All are accustomed to laboratory equipment and to varied types of laboratory tests. The members of this group, who are designated by letters A to H, were all born in 1925. At the time of the beginning of the learning series, the oldest was just five years of age, and the youngest was four years and four months old. All the children except one are of native born parentage. The mother in this case is of foreign birth. The group as a whole is of superior intelligence, showing an average intelligence quotient (Stanford-Binet) of 113. All the children are well nourished and reported by medical examination in good health and without defects.

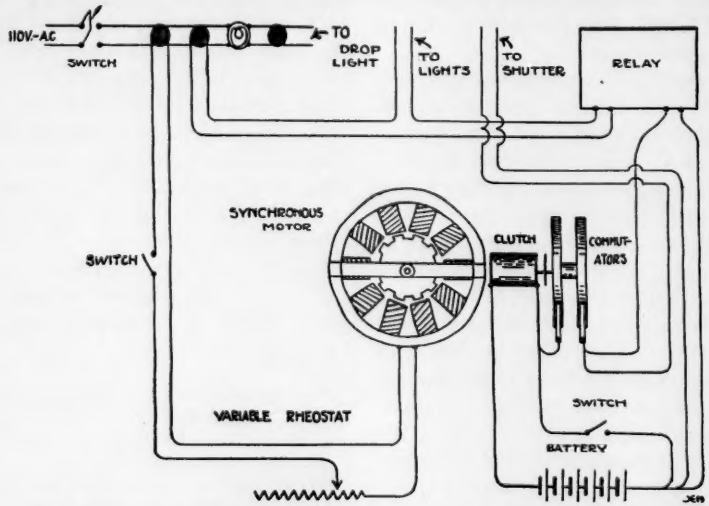

FIG. 1. WIRING DIAGRAM OF APPARATUS FOR HAND AND EYE COÖRDINATION

APPARATUS AND METHOD

Apparatus

The apparatus used for testing hand and eye coördination is a controlled aiming device. The reactor stands facing the wooden screen (*S*) in which there is a small rectangular opening, an eye aperture, admitting a lateral sliding binocular eyepiece. The view of a target seen through the eyepiece may be intercepted by a descending shutter (*I*) operating on the back of the screen (*S*). This rectangular screen is high enough for the forearm to be passed under it easily. The hand is thus entirely free from interference or obstruction of any kind when thrusting at the target.

When the metal shutter (*I*) is raised, four lights flash on in synchronism, bringing into high relief the target, a colored marble, held in the middle of a rectangular field 13 inches from the eyepiece. The marble fits snugly into a hole in the composition board field, and can be punched out by a very light thrust with the brass stylus held by

the child. This sharp stylus is $5\frac{7}{8}$ inches long and weighs $\frac{3}{4}$ of an ounce. Attempts which do not hit the bull's eye (marble) are recorded by the punctures which the pointed stylus makes in a sheet of plain white paper fastened over a thickness of felt across the target board.

The mechanism which controls the shutter is so timed as to allow $\frac{3}{5}$ of a second exposure of the target with intervening non-exposure intervals of 4 seconds. These periods are regulated by two commutators (fig. 1) as described below. In addition to regulating the exposure intervals of the target, the commutators also control the synchronized flashing of the four lights, which accompanies the lifting of the shutter. These lights are mounted on the back of the wooden screen (*S*), thus shielding the child's eyes from glare and facing the target which they periodically illuminate.

Above the shutter is hung a 100 watt incandescent lamp (*R*) in a reflector. This continuous light is used throughout an experimental period to enable the experimenter to see clearly the position of the reactor's hand, and to note the location of the successive stylus punctures.

The aiming device is arranged on an adjustable box-like carriage which slides perpendicularly by weights and pulleys in a wooden framework (*F*) 78 inches high and 50 inches wide. (See diagram, figure 2). On the front of the carriage is the wooden screen (*S*) which contains the eye aperture and which also has, mounted on its back surface, the binocular pieces (*P* and *G*), the interposed shutter (*I*) and the synchronized lights. The rear wall of the carriage is formed by the target board, which in the diagram, figure 3, has been omitted in order to afford a view of those accessory parts mounted on the back of the front screen (*S*). The vertically sliding carriage thus makes it possible to move the front screen and the target as a unit and to vary their height according to the height of the individual child.

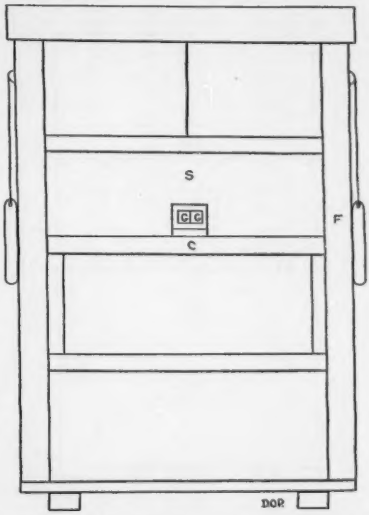

FIG. 2. DIAGRAM OF APPARATUS FOR HAND AND EYE COÖRDINATION. FRONT VIEW

The wooden screen (*S*) which forms the front of the carriage is $39\frac{1}{2}$ inches wide and 14 inches high. The eye aperture in the middle of the lower edge is $3\frac{1}{4}$ inches wide and $3\frac{1}{8}$ inches high. Into position immediately behind this aperture can be slid either of the binocular pieces, which are mounted in a wooden frame easily moved in a horizontal direction.

Two 20° crown glass prisms, each

2 inches square, and having a refracting value of approximately 20 prism diopters, are mounted base left side by side to make the eyepiece (*P*) which displaces the field of vision toward the right. On a horizontal line with the prism eyepiece and in the same horizontally movable wooden frame (*H*) is a plain glass binocular piece (*G*). The plain glass eyepiece

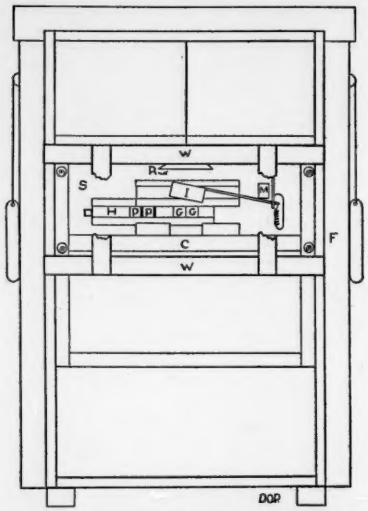

FIG. 3. DIAGRAM OF APPARATUS FOR HAND AND EYE COÖRDINATION. REAR VIEW

is made of two 2-inch squares of plate glass which are mounted, as are the two prisms in the other eyepiece, about $\frac{5}{16}$ of an inch apart. The narrow division space in the eye piece provides for the varying interpupillary distance of the children in the experimental group. A heavy glass is used in order that the child's impression of the thickness of the medium in the two eyepieces may be more nearly equalized. The mounting of the two eyepieces (*P* and *G*) in horizontal line on the horizontally sliding frame (*H*) enables rapid change from deflected to normal vision, or *vice versa*, with a minimum distraction of the child. Stops are placed on the back of the wooden screen (*S*) on either side of the eyepiece mounting (*H*). These restrict the excursion of the sliding frame so that the desired eyepiece is quickly placed in correct adjustment with relation to the eye aperture. That part of the wooden framework immediately below the eye aperture is cut away to give room for the nose and to facilitate breathing, thus avoiding the clouding of the eyepieces. A double sateen curtain (*C*) 5 inches long is hung from the lower edge of the screen to discourage any tendency to look below the eyepiece or, previous to the exposure period, to hold the hand at a height approximating the level of the target.

A metal shutter (*I*) 5 inches long and $2\frac{1}{2}$ inches high is mounted $1\frac{1}{2}$ inches behind the eye aperture. This shutter is raised by an electromagnet (*M*) and a coil-spring device. When the magnet releases the shutter at the end of the exposure period, the shutter falls back into its original position behind the eyepiece, thus cutting off the view of the target.

The target is mounted on a composition board field, 48 inches long and 16 inches high, which can be moved laterally to the left or the right in the perpendicularly sliding carriage. The possibility of such lateral movement facilitates adjustment and removal of the target paper. The wooden supports (*W*) of the target board are fastened to the screen by 4 brass rods

which fit into adjustable sleeves fixed to the 4 corners of the screen (*S*). The use of the adjustable rod and sleeve coupling makes it possible to vary the distance of the target from the eyepiece according to the length of the child's arm. This adjustment is not used in the present experiment, since the arm length of this group of children of the same age shows no such variation as to warrant the expenditure of time necessary for adjustment. The distance of 13 inches from the eyepiece to the target is used throughout.

Two 6-inch stationary spring paper clips fixed on the target board hold a removable target sheet of plain white paper, 24¼ inches long and 14 inches high. This target sheet is renewed for each practice period consisting of 10 attempts (thrusts).

In the middle of the target field is a round hole $\frac{9}{16}$ of an inch in diameter, just large enough to hold snugly a cheap clay marble, a "commie," used in a variety of colors. A bag catches the marble when punched out.

Two commutators, which are driven by a synchronous motor of the type used in the Dunlap chronoscope, are used to regulate the time interval of the shutter and the four lights. Power for the motor is derived from a 110 volt, alternating current controlled through a variable rheostat. Wiring is in series (see diagram, figure 1), the circuit to the four synchronized lights being passed through a relay. The lights thus are operated from the motor by means of the commutators and the relay. A 6-volt storage battery furnishes power for the clutch, and for the magnets which control the shutter.

The continuous illuminating drop light above the sliding carriage uses the same 110 volt, alternating current that drives the motor.

Theoretical values of the controlled aiming test

The present apparatus for testing hand and eye coördination was designed by Dr. Knight Dunlap to control, partially at least, some of the highly variable factors encountered in the writer's use of the Whipple free-aiming test with young children. The prism eyepiece was added to the set-up in order to provide a further study of learning involving hand and eye coördination in this more complicated perception pattern.

A main point of departure consists in the use of an eye aperture and an eyepiece interposed between reactor and target. The eye aperture provides for a uniform distance between eye and target for children of the same arm length. In an aiming test, a directed foot position alone, or even a foot position behind a stop or with stirrups is insufficient for the young child who in his eagerness may bend far forward. The repeated cautions necessary for preserving even approximately uniform distance and postural relationship to the target tend to be repressive in nature and may become irritating to the reactor. The use of an eye aperture in a screen produces on the part of the child a practically automatic adjustment to a uniform distance and a uniform bodily posture.

The 5-inch curtain of a somewhat heavy material, as attached to the lower edge of the screen, provides a still more extensive shield to prevent

direct vision of the target. Its flexible nature affects little if at all the free movement desirable in thrusting at the target. The lower edge of the curtain gives the height at which the child's hand is to be held between exposure periods. Thus, without curtailment of freedom of arm movement, a definite designation of a resting hand height, uniformly proportionate to the individual height, is provided. Such a uniformly proportionate preparatory hand height as a starting point for the thrusts is obviously highly important if results of aiming are to be comparable. Here the attempt is made to secure uniformity more perhaps by suggestion than by any other means. The curtain, although no real barrier, may reinforce the suggestion. The mechanism of a hand rest, seems to impose too great a likelihood of obstruction to free movement.

A second point of advantage in the use of an eye aperture lies in the fact that it makes possible the employment of a shutter and a brief exposure period accompanying each thrust. In devising any short-arm aiming test, an important source of error lies in the difficulty of obtaining a comparable type of arm movement. Speed of movement in such a test may be highly variable, and when variable must change the type of muscular coördination and markedly affect precision. In the present controlled aiming device, the necessity imposed by the lights and the descending shutter, as reinforced by the timed vocal command "Punch!" again automatically, tends to produce a satisfactory degree of regularity. The brief exposure period forces a rapid whole arm movement, thus greatly increasing the probability of uniformity in type of muscular coördination used by the different reactors.

The value of the prism eyepiece in furnishing a means of more intensive study of the factors involved in learning a skill which requires fine precision in hand and eye coördination is obvious. The use of the plain glass binocular piece instead of a simple aperture, for practice periods employing normal vision, has definite control value.

Punching a colored marble out of a hole before the lights go off and the shutter comes down may have some of the same age-old qualities of allurement as a peep show. Children show little real zest for the Whipple aiming test. In the present test there would seem to be presented a more gratifying type of performance possessing a continuing interest. This interest, it is believed functions as an intrinsic motivation, which is highly necessary for a somewhat prolonged learning experiment.

Procedure

A practice period of 10 thrusts, or attempts, is used throughout the series. This, although a quite short period, is not too brief for the observation of practice effects. It also possesses the advantage of practically eliminating effects of fatigue and boredom which, if present in an experiment such as this using displacement of the visual field, may so cloud the results as to prevent any definite conclusions. The puncture marks of this short arm test cluster somewhat closely around the bull's eye, two thrusts occasionally

falling on the same or nearly the same point. A target sheet containing ten closely grouped punctures can be accurately numbered and scored. A larger number than ten, however, on the same target sheet leads to confusion and inaccuracy. The total practice period of ten exposures calls for a minimum of forty-eight seconds from the moment of the first warning signal. When a marble is struck out, the experimenter without change of position or stopping of the mechanism, inserts another.

The child faces the front screen. He sees the marble target through the plain glass eyepiece and is given the pointed metal stylus with the following instructions: "You are going to have a chance to punch that marble out of the hole. Stand here, and look through the peep-hold. Hold your hand just below the curtain. When the lights flash on, punch the marble out of the hole. You will have to be quick to punch it before the lights go off. I shall first say 'Ready.' Then when I say 'Punch!' you hit the marble."

The motor is started, and the switch is thrown, thus starting the flashing of the synchronized lights and the simultaneous lifting of the shutter. The experimenter holds a diagram of the target field divided into four equal sectors or quadrants around a circle representing the bull's eye. Spacing the vocal signals by the exposure periods, a two second warning signal, "Ready" is given. The signal "Punch" comes with the flashing of the lights. The child makes a quick thrust at the target, dropping his hand immediately afterward during the non-exposure interval to the lower edge of the curtain. During this rest period the arm is usually held quiet in a position forming approximately a ninety degree angle at the elbow.

Immediately following each of the 10 thrusts of a practice period, the experimenter records by sequential number in the appropriate quadrant of the diagram the approximate position of the puncture. Quadrants are used on the diagram only as a device to secure accurate numbering later of each successive puncture on the target sheet, for from this diagram the number of each stylus contact with reference to its place in the sequence of ten attempts is transferred to the actual punctures as appearing on the target sheet. A separate diagram is necessary for each practice period.

The procedure is uniform except for change from one eyepiece to the other as necessitated by the variation in the series. In the plain glass series, obviously the plain glass eyepiece is used, as, in the prism series, the prism eyepiece is necessary. The mixed series requires the quick change of eyepiece after the fifth thrust.

Method of scoring records

A single target sheet shows the record for one practice period consisting of 10 thrusts at the target. The record sheet has in its center a round hole around which are distributed the stylus punctures, each numbered according to its place in the sequence of the 10 successive thrusts. Sequential numbers of the bull's eyes are noted at the top of the record. Millimeter stencils are used to secure three measurements on every punc-

ture. These three measurements show

(1) Positive (right) or negative (left) distance from the perpendicular axis.
(2) Positive (above) or negative (below) distance from the horizontal axis.
(3) Radial distance from the center of the target.

The algebraic sum of positive distances and negative distances from the vertical axis is divided by 10 to find an average figure showing relationship to the vertical axis. This calculation is of particular interest because of the displacement of the field of vision twenty degrees from the vertical axis as produced by the prism eyepiece used in some of the series. Similarly, the algebraic sum of positive distances and negative distances from the horizontal axis is divided by 10 to give an average figure showing a relationship to the horizontal axis. This calculation being uninfluenced by prismatic deflection in any of the series can be used as a control in the prism and the mixed series for comparison with the calculation based upon the influence of deflection. The sum of the radial distances from center is divided by ten to get an average from center.

In the mixed series, which uses prism eyepiece for 5 thrusts and plain glass eyepiece for 5 thrusts, the same measurements, sums and averages are made. However, here they are made on a basis of 5, the 5 prism hits forming one set of calculations and the fine plain glass punctures forming a separate set of calculations, thus making two complete sets of calculations for every record sheet in the mixed series. Three distinct relationships based directly upon original measurements are thus calculated and tabulated for every record.

Program of experimental series with theoretical implications

The experimental program used in the test of hand and eye coördination is planned to include four variations: a) An initial practice series using the plain glass eyepiece, 10 practice periods; b) a prism practice series using the prism eyepiece, 10 practice periods; c) a mixed series using prisms for five successive thrusts and plain glass for five successive thrusts, order alternating, 12 practice periods; and d) a final control series coming back to the use of the plain glass eyepiece again, 3 practice periods.

Three weekly practice periods are given, coming on Monday, Wednesday and Friday.

Motivation of performance

The child shows enthusiasm for this test. The "peephole," the flashing lights and the descending shutter add intrigue to the situation, but the activity of "punching the marble" is so planned as to possess high intrinsic motivation. Strong approval is given to all successes. Because of the high intrinsic motivation, only a small extrinsic reward is deemed necessary even for the long experimental program. For three successes in one practice period (ten attempts) the child is allowed to choose a marble to carry to a box in the nursery school.

RESULTS

Data of the prisms experiment are given in tables 1, 2, and 3. Results

TABLE 1

Means and standard deviations of control and deflection series

REACTOR	SEX	AGE	TRIALS	INITIAL UNDEFLECTED (GLASS) SERIES						DEFLECTED (PRISMS) SERIES					
				Direction of error											
				Horizontal		Perpendicular		Radial		Horizontal		Perpendicular		Radial	
				M	σ	M	σ	M	σ	M	σ	M	σ	M	σ
H	F	4:5	10	−.1*	4.7	3.6	5.3	17.1	4.0	3.1	5.8	5.1	4.5	13.2	4.5
E	F	4:9	10	−1.8	3.6	4.7	9.6	20.1	4.7	9.6	10.5	−2.4	4.7	20.5	8.0
F	F	4:4	10	3.5	6.2	2.9	12.4	22.4	12.3	13.0	7.9	.2	7.2	19.6	8.1
D	F	4:9	10	−3.6	2.8	−5.6†	11.7	23.7	11.2	4.7	7.0	−2.9	6.9	20.2	5.6
Mean	F	4:7	10	−.5	4.3	1.4	9.8	20.8	8.1	7.6	7.8	0	5.8	18.4	6.5
B	M	4:5	10	5.2	3.8	−.2	6.8	16.2	4.4	13.3	3.7	4.0	5.9	20.2	6.2
G	M	4:5	10	−.6	3.3	−8.1	4.0	17.4	2.8	7.7	9.1	1.0	3.8	20.0	5.8
A	M	5:0	10	5.2	3.5	.6	7.9	19.7	6.9	6.1	4.6	−3.9	5.8	19.3	2.7
C	M	4:10	10	1.7	7.9	6.9	4.8	19.8	8.8	10.9	7.5	−.8	7.7	25.4	6.0
Mean	M	4:8	10	2.9	4.6	−.2	5.9	18.3	5.7	9.5	6.2	.07	5.8	21.2	5.2
Mean	F–M	4:7	10	1.2	4.5	.6	7.8	19.6	6.9	8.5	7.0	.03	5.8	19.8	5.8

* In the horizontal means the minus sign denotes direction left of the center.

† In the perpendicular means the minus sign denotes direction below the center.

TABLE 2

Means and standard deviations of alternate series

REACTOR	SEX	GLASS FIRST						PRISMS FIRST					
		Horizontal		Perpendicular		Radial		Horizontal		Perpendicular		Radial	
		M	σ	M	σ	M	σ	M	σ	M	σ	M	σ
E	F	−26.1	5.8	−30.4	14.0	44.1	9.3	−1.2	6.0	−24.4	16.0	32.0	11.1
F	F	12.3	18.8	−17.4	7.1	33.8	16.1	27.6	3.0	−7.7	7.7	35.5	4.5
D	F	−10.6	6.1	−3.3	2.9	22.0	2.1	10.1	8.0	−5.9	6.6	22.4	4.7
Mean	F	−8.1	10.2	−17.0	8.0	33.3	9.2	12.2	5.7	−12.7	10.1	30.0	6.8
B	M	−7.7	9.4	−3.8	10.0	23.0	20.0	15.7	3.4	−.6	9.1	21.9	5.9
A	M	−10.6	5.3	−12.4	6.8	21.1	5.5	16.2	6.1	−11.9	8.9	25.3	8.4
C	M	−6.3	10.2	−10.7	21.1	34.4	12.5	11.4	9.1	−2.0	5.2	25.1	4.7
Mean	M	−8.2	8.3	−9.0	12.6	26.2	12.7	14.4	6.2	−4.8	7.7	24.1	6.3
Mean	F–M	−8.1	9.2	−13.0	10.3	29.7	11.0	13.3	5.9	−8.7	8.9	27.0	6.5

recorded are presented as tentative but indicative, not as conclusive. It will be recalled that the scores represent millimeters error, the smaller score consequently indicating the better performance.

Analysis of variations in series

Table 1 gives results in the initial control (glass) and the deflection (prisms) series, each based on 10 trials. Means of the initial control series reveal only negligible differences between errors on the horizontal and the perpendicular axis, though the standard deviation on the perpendicular axis is perhaps significantly greater. More efficient use of visual cues with regard to lateral deviation in hand and eye coördination as evidenced here may perhaps logically be related to the correction of lateral sway by vision. On the other hand, adjustment to center on the horizontal plane is subject only to the reactor's preference, whereas such adjustment on the perpendicular plane is conditioned also by the degree of perfection in the placement of the apparatus for the individual.

Comparison of the means of the two series shows in the prisms series the expected increase in horizontal error to the right of the center with an accompanying increase also in the standard deviation. On the perpendicular axis, on the other hand without disturbance by deflection, definite practice effects are seen in the considerable reduction of the mean errors. On the perpendicular axis the relatively small increase in the standard deviation associated with the considerable decrease in the mean appears especially significant of practice effects, since it might be supposed that greater spread on one axis would ordinarily be accompanied by increased variation

TABLE 3

Means and standard deviations of alternate series

REACTOR	SEX	GLASS SECOND						PRISMS SECOND					
		Horizontal		Perpendicular		Radial		Horizontal		Perpendicular		Radial	
		M	σ	M	σ	M	σ	M	σ	M	σ	M	σ
E	F	−23.9	5.1	−16.0	14.7	34.1	9.0	8.6	8.0	−25.1	2.8	31.9	4.1
F	F	−7.3	7.6	−5.4	8.0	16.9	4.1	21.9	3.7	−5.1	12.2	29.1	9.8
D	F	−23.6	8.9	−8.6	9.3	30.3	9.1	21.2	5.4	−1.4	4.8	25.0	6.4
Mean	F	−18.3	7.2	−10.0	10.7	27.1	7.4	17.2	5.7	−10.2	6.6	28.7	6.8
B	M	−14.8	4.5	6.2	10.5	24.7	7.9	22.9	7.0	−3.7	11.9	28.3	10.1
A	M	−19.4	9.9	−11.9	16.4	28.6	14.7	16.9	3.9	−9.2	4.2	23.1	3.6
C	M	−17.3	11.0	2.5	14.8	24.2	11.9	33.2	27.4	−3.3	10.2	41.9	24.6
Mean	M	−17.2	8.5	−1.1	13.9	25.8	11.5	24.3	12.7	−5.4	8.8	31.1	12.8
Mean	F-M	−17.7	7.8	−5.5	12.3	26.4	9.4	20.7	9.2	−7.8	7.7	29.9	9.8

on the other. This tendency appears to be evidenced but by practice is here held considerably in check. That the radial errors remain approximately the same with indeed a small decrease in standard deviation in spite of the manifest disturbance on the horizontal axis is another evidence of the progressive practice effects with reference to errors on the perpendicular. Individual differences as to the amount of increase in mean horizontal error caused by deflection are marked.

In the alternate series which followed the straight prisms series 12 trials are included. Tables 2 and 3 are therefore based on 6 trials with glass first and prisms second and 6 trials with prisms first and glass second.

The means for the 6 trials, in which the five attempts without deflection are scheduled first, appear in table 2 under the caption "Glass first." These data appear theoretically to have the following points of difference from the results recorded in table 1 for the initial glass series:

a. General practice effects in hitting the target should be more noticeable in table 2 since it shows a later segment of the learning program.
b. The more lasting as opposed to momentary effects of deflection on the horizontal axis may be expected to show here.
c. "Warming up" effects within any one trial may be reduced since these trials allow only 5 attempts with glass and 5 with prisms as opposed to 10 attempts of the one or the other in table 1.

Means of the horizontal errors in the "Glass first" trials of the alternate series exhibit markedly the reversal of error noted as an after effect by Helmholtz (2) and by Sanford (4). A large mean left error almost approximating the mean right error in the simple deflection series, and having a larger standard deviation is recorded. Both perpendicular and radial errors show large increase in the means as well as in the standard deviation in line with the previously expressed expectation of association of increased error on one axis with similar increase on the other. Individual differences are again notable. The alternate series shows marked evidence of general disturbance of the mechanism of the eye reflexes. These first 5 attempts without deflection in the trials placing glass first may be supposed to be the nearest approach to normal vision. Yet even here, confusion is apparent and that not confined to the one axis on which distortion occurs. The large perpendicular error below center is probably due to this general disturbance, and occurs below rather than above because a short thrust from a position below the target is necessitated. The adjustment of the height of the target to the individual need was no less careful during this series. From the data of the alternate series in the 5 attempts without deflection which occur first in order, the more lasting effects of distortion appear sufficient to cause general disturbance in accuracy on both axes. Effects of practice as observable in former series are apparently quite inadequate against the frequent change, at least as shown by mean averages.

Data of the 5 attempts using glass

immediately following deflection are presented under the caption "Glass second" in table 3. These results may perhaps be expected to magnify the effects already summarized for the "Glass first" data. Comparison of the means shows a horizontal error to the left more than twice as large as in the "glass first" data, a striking evidence of the reinforcement of the more lasting by the immediate opposite after effects of muscular compensation. The mean of perpendicular errors is greatly reduced but with increased deviation, and the mean of radial errors is considerably reduced. Under "Glass first" are given the results of the first 5 attempts of these trials and under "Glass second" are recorded the data of the last 5 attempts of the "Prisms first" trials. It therefore appears probable that the reduction in the means of the perpendicular and the radial errors in the "Glass second" data as compared with the "Glass first" data may be due to "warming up" effect during the 10 attempts.

The "Prisms first" attempts of the alternate series may be expected to bear the same relationships to the preceding simple deflection (prisms) series as those listed above for "Glass first" in comparison with the original undeflected series. The same general disturbance of reaction is shown as previously mentioned in connection with the "Glass first" results though perhaps in not an equally irregular manner. The mean horizontal error is greater than in the simple "Prisms" series but with a slightly smaller standard deviation. This increase is presumably due to the elimination of the last 5 more nearly accurate thrusts at the target. The mean perpendicular error is greater and thrown below the center; the mean radial error is greater; both standard deviations are increased. Individual differences are marked with some greater tendency to uniformity among the boys. Evidence of general disturbance of response pattern is much similar in both the "Glass first" and the "Prisms first" data. It is interesting to note that with the compensatory error to the left in the "Glass first" results is associated a greater perpendicular and also radial error and a much greater variability throughout than with the parallel distortion error of the "Prisms first" data. Such a difference might be due in part at least to an expected greater inaccuracy of the thrusts of the right hand when thrown into the field to the left of center as compared with its efficiency in the nearer field to the right of center.

Data of the "Prisms second" records may be expected in horizontal errors to superimpose upon the more lasting effects of distortion the exaggerations of immediate effects of the same. On the perpendicular axis however whatever increase of efficiency is referable to last 5 as compared with first 5 thrusts should operate to decrease the error. The mean horizontal error is found, as expected, to be much increased. However, means of perpendicular and of radial errors are also larger, which is contrary to expectation in connection with "warming up" effects but in line with the tendency of increased spread on one axis to be associated with increased spread on the other.

The three control trials at the end

of the learning program use uniform stimulation without deflection. The results are presented in tables 4 and 5. They indicate the amount of progress toward elimination of compensatory modifications built up by deflection. The "Glass first" data of table 2 affords the best means of ascertaining progress. Comparison of the means

TABLE 4

Means of final control series (Glass)

REACTOR	SEX	AGE	TRIALS	HORIZONTAL	PERPENDICULAR	RADIAL
F	F	4:4	3	+5.37	−3.3	13.4
E	F	4:9	3	−13.50	−10.1	15.4
C	M	4:10	3	+9.43	+8.1	21.4
B	M	4:5	3	+1.43	+13.8	25.8
A	M	5:0	3	−4.20	−3.03	31.9
Mean..	F–M	4:8	3	−3.9	+1.1	21.6

TABLE 5

Means of final control series (Glass)

REACTORS	AGE	TRIAL	HORIZONTAL	PERPENDICULAR	RADIAL
5	4:8	1	−4.8	−.56	20.3
5	4:8	2	−3.1	−3.1	22.5
5	4:8	3	−4.1	+7.0	22.0
5	4:8	3	−4.0	+1.1	21.2

shows about one-half of the horizontal error eliminated in 3 trials. Perpendicular error is reduced to near that of the original undeflected series (table 1, Glass). Radial accuracy is slightly less than in this first series. That the return however under conditions of normal vision is fairly rapid is indicated. The need for a longer control series is obvious particularly for study of the marked individual differences. The individual hits of the final undeflected trials gives a clear picture of the process of recovery from the effects of angular deflection.

Indications of the modifiability of visual reflexes as evidenced in this experiment are in line with the results of Wooster (8) and of Ewert (1). The mechanical progress of this modification as brought out in the reaction of the young child is particularly striking. That modifiability in either direction on the horizontal axis is about equal is to be expected in symmetrical action of the eye muscles. The return under conditions of normal vision is no doubt facilitated by the many daily reactions which tend to overcome the effects of the exceedingly short experimental practice period. As judged by the means it does not appear that any considerable progress toward accuracy in aiming is possible under the changing conditions of the alternating series. The changing stimulus apparently tends to produce a balanced constant error to either side. The selective method by which this balance is achieved is more clearly brought out in the individual thrusts and in the hits.

Sex differences

Boys show superiority in total accuracy as indicated by the radial errors in all except the straight prisms series (table 1). Their superiority under the confusion of the alternate series is quite marked.

Boys show practically throughout a greater uniformity of performance. This might be due to less variability in skill, to less sensitivity to disturb-

ance of pattern or perhaps simply to chance distortion in the small sampling.

The greater uniformity of the boys brings out nothing particularly notable in individual differences. A and B in the simple deflection series show much less original displacement than any of the girls and also less proficiency in correcting for that small displacement.

From the sex differences and from the variation of individual performance, two general groups of factors operative in this test are indicated. Factors of modifiability of eye muscles constitute one group. While obviously a part of precision in aiming, yet in these data rapid and accurate compensatory adjustment of eye muscle mechanisms does not appear to be necessarily associated with precision in aiming under conditions of normal vision. Other factors also are apparently operative in producing fine precision of hand and eye coördination. Disregarding vision in itself, it is tentatively advanced here that two chief factors may be an eye muscle-brain segment and a hand-arm-brain segment which operate in producing the total reaction. It is also possible that either of these segments may possess a variable efficiency which therefore independently conditions the efficiency of the total hand and eye coördination.

Individual differences

Individual differences as shown in the data are marked in amount and in variety.[2] These are discussed throughout the text and summarized at the end. The graphs of figure 4 show individual performance of each child throughout the learning program.

Force of movement in striking is an individual variation not measured by the device used.

Practice effects in the individual thrusts

Perhaps the most illuminating study of the compensatory process operative under visual deflection is afforded by analytical examination of the ten successive attempts of each trial.

In the initial undeflected series, the distribution of horizontal errors to right and to left and their variation as to size within any one trial apparently show a large chance effect. However, the number of hits in the last 5 attempts is seen to be considerably larger than in the first 5. Thrust number 10 totals more hits than any other in the undeflected trials. There appears therefore to be some practice effect within the daily trial. Practice effects from trial to trial are recorded in the average error for each trial.

The deflected series shows rather rapid compensation by the eye muscles within each trial. Three children show all positive (right) errors in the first prisms trial, one being able to proceed no nearer than 11 mm. from the vertical axis. The other 2 approach to within 2 mm. of the axis, thus showing excellent progress from the 48 and 44 mm. errors of the first deflected attempt.

Four children show at least one rather large negative (left) error even during the first deflected trial. These occur on the fourth, fifth, seventh and eighth thrusts. Two make a hit on

[2] Individual tables and case studies are given in the original of the dissertation filed in the library of The Johns Hopkins University.

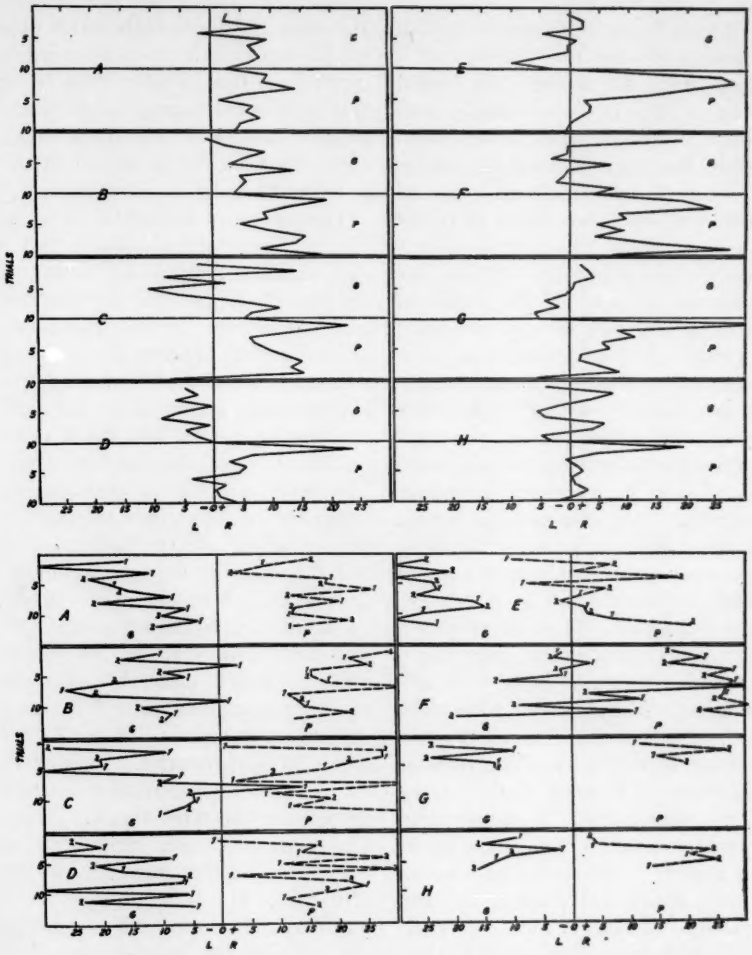

FIG. 4. EYE AND HAND COÖRDINATION

Graphs showing individual performance based on horizontal errors in ten undeflected trials, ten deflected trials, and twelve alternate trials. *G* indicates undeflected (glass) series. *P* indicates deflected (prisms) series. Numerals *1* and *2* in alternate series indicate glass first or glass second and prisms first and prisms second in the trial.

the third and the tenth thrusts of the first prisms trial.

Though there is obviously a certain tendency for the first attempt of a prisms trial to produce the largest error, yet this is not necessarily true. Also in a deflected trial, as mentioned above, the larger number of hits for the last 5 trials indicates general practice effects in the course of the 10 attempts. However, there is operative another more variable influence seemingly inherent in the degree of strain produced in the last preceding response. A considerable over-compensation to the left, or a hit may be countered by a large right error immediately following. A close approximation to equality in successive left and right errors is frequently observed. This influence of strain, fatigue or whatever it may be, probably accounts for some tendency to rhythm which is observed within the 10 attempts of a trial. There is apparently close concentration and progressive improvement through 3 or 4 thrusts followed by relaxation to a wider error to the right and the necessity of again working in to center. The unusual proficiency of Reactor H during the prisms series seems to be accompanied by reduction of the size of the errors and also by a shortening or even an almost entire overcoming of any rhythmic tendency. She shows no tendency toward alternating concentration and relaxation.

Ewert (1) in localization experiments with visual inversion reports a gradual dropping out of errors rather than a reduction in the size of errors. In the present experiment, using angular deflection, there is considerable evidence for reduction of the size of errors during the straight prisms series. However, in the alternate series what gain is made appears to be achieved by increase of hits in later trials rather than by marked decrease in the size of errors. Results for only the alternate series therefore are in accord in this respect with Ewert's observation.

The record of horizontal errors on the first thrust of each prisms trial is quite significant as probably indicating the more lasting effects of compensatory adjustment. Reactor H registers an interesting progress on the first thrusts. The error of the second trial is exceedingly small. After the third trial the error of the first thrust never reaches half of the original error. The two hits and the one over-compensation on the first thrust are particularly notable. Every reactor but C and E shows overcompensation in one or more trials even on the first thrust. Four, including E, show hits on it. C, who holds low score on the prisms series, appears unusually slow to make compensation. His first thrust throughout except on the tenth trial shows large right error. Reactor G, shows a somewhat regular learning process on this first thrust. Beginning with a 50 mm. right error, he proceeds to a 2 mm. right error on the fifth trial. He then proceeds with continued left errors and one hit to the considerable over-compensation of a 36 mm. left error on the tenth trial. Others are more highly variable, some exceedingly so, as to the amount of "hold over" shown by the first thrust.

In the alternating series, the daily averages and the individual means

mask a rather nice selective ability which comes out in the records of some reactors with study of the horizontal errors of the single thrusts. Reactor H, from her excellent scores for the straight prisms series, carries over to the alternating series an excellent compensatory adjustment. Her errors for the first two alternating trials are small in comparison with the errors of the other children on these same trials, and she makes one hit each day. However, with this confusion stimulus pattern, her errors increase markedly; her hits decrease, and she becomes rather indifferent and discouraged by the fifth and sixth trials. It is now believed, particularly from the few hits obtained by any child in the alternating series, that a larger target, perhaps three-fourths of an inch in diameter might be an improvement. By increasing hits and therefore motivation, more clean-cut results might be produced. In an alternating series, the child theoretically proceeds to a balanced adjustment of the deflection error and the after-over-compensation error. This necessitates an increase of deflection errors till the point of balance is reached. Reactor A may be said to reach this point of adjustment in trials 7 and 8 of the alternating series which show a fair approximation of positive (right) and negative (left) errors. With an equilibrium thus established, he proceeds slowly to greater accuracy as shown in the reduction of the error in the first thrusts of trials 10 and 12 in the Prisms first data. The hits in the alternating series illustrate this selective adjustment. Most of the children score some hits in the first few trials, few if any in the middle period of adjustment but an increase from Trial 9 on, indicating it seems that the child now has some basis of equal compensation from which to work.

Sudden large and unexplainable errors are observable in many of the records. The opinion has been that perhaps these were referable to fatigue or muscle strain, at least to a physiological cause. Ewert (1) also reports these as occurring in touch, sound and visual localization. He is inclined to attribute them to a lapse in the instruction stimulus. If the sudden wide errors in Ewert's results and in the present data are of similar nature, and referable to similar cause, the child's reaction here is perhaps particularly significant, since it cannot be attributed to lapse in instructional stimulus. A different cause is apparently to be sought which may or may not be physiological, as here advanced.

Absence even up to a month as shown in G's record apparently does not effect the course of performance. This evidence of permanence is particularly interesting in view of the rapid adjustment in the very short final series.

SUMMARY

This investigation provides only tentative evidence. Its purpose has been largely exploratory in a field where with young children little or no work has previously been attempted. Though previously emphasized, it is reiterated here that these results from a limited number of reactors are presented as indicative, not as conclusive in any way.

A study has been made of motor learning in hand and eye coördination. For this purpose an apparatus for controlled aiming using prisms deflection has been used. An extended learning program with specific stimulus variations has been carried on using eight children of mean age 4 years 7 months.

Results are as follows:

a. Means of a deflected series as compared with a series using normal vision show increased right horizontal error and simultaneously decreased perpendicular error for the angular deflection series.

b. Progress in a series alternating normal vision and deflection is apparently toward a constant horizontal error approximately equal to right and to left. The increased left error has greater variability and is associated with greater perpendicular and radial error.

c. Final undeflected trials show fairly rapid recovery from effects of deflection.

d. These boys show greater uniformity of reaction throughout and superiority in accuracy except in the straight deflected (prisms) series where the girls lead.

e. Individual differences are marked and highly variable. They are observable under normal vision in amount, variability and direction of horizontal error. With angular deflection to the right the amount of right error, the immediacy, speed, consistency and degree of return all show individual variation. Ability in selective adjustment toward approximation of left and right errors in an alternate series, speed of recovery following deflection and force exerted in striking show individual variation.

f. Practice effects within a trial are observable by comparison of last five with first five thrusts. Compensation for deflection is rapid within the trial. Decrease in error of the first thrust is observable in successive trials and is apparently indicative of the trend of compensatory modification in any series. Gain proceeds by both reduction of individual errors and increase of hits except in the alternate series. There it is by increase of hits with attainment of right and left approximation.

g. A slight correspondence between efficiency in the different series is seen, though a reactor ranking low in precision under normal vision may make rapid and accurate compensation for deflection.

Suggestions for further experimentation using angular deflection

a. Repetition with adults to secure comparative data between children and adults as to modifiability of compensatory mechanisms. Such data are important as bearing upon the apparently greater emphasis upon visual cues as used by adults for improvement in equilibrium.[3]

b. Addition of blindfold series to the adult program mentioned above. A blindfold series may bring forth any individual differences in the comparative influence of the hand-arm-brain segment and the eye muscle-brain segment as conditioning the total

[3] Data of equilibrium are given in original dissertation, The Johns Hopkins University.

mechanism of hand and eye coördination.

c. Repetition of the same program upon a five-year-old group limited to a two months age range. A target three-fourths of an inch or even an inch in diameter and perhaps a longer alternate series might be tried out. The use of a phorometer for previous and subsequent test of muscular symmetry constitutes a worthwhile addition to the data.

d. Repetition with a group of left-handed children.

e. Repetition with the target placed a sufficient distance to the left of center to cause it under right deflection to appear at center.

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Range of Variability in Weight and Height of Children under Six Years of Age[1]

MEDORA B. GRANDPREY

TODAY great emphasis is placed upon the desirability of weighing and measuring children as a method of obtaining an index of their nutrition and development. Parents are urged by physicians and educators to keep records of weight and height of their children and in most nursery schools measuring weight and height are routine procedures. The standard tables in present use, namely, Baldwin-Wood tables for school children and Woodbury tables for preschool children, are based upon the average weights for the given intervals of age and height. Normal variability in weight for a given height and age due to differences in body build is arbitrarily allowed for by assuming that a child who is either 7 per cent below average or, according to some authorities, 10 per cent, is malnourished and one who is 15 per cent above average is overweight.

In criticism of this custom, Faber (1) pointed out that these zones are inadequately defined. From his study of 34,000 San Francisco children, Faber concludes that "variability in weight for height in the direction of both underweight and overweight increases with age in both sexes, that girls show both a greater variability and a more rapid increase in variability with increasing age than do boys, and that these differences and variations in variability are too great to be disregarded in favor of a single standard of variation such as is now in general use." After extensive analysis of the data, Faber assumed that children with weights below the 10 percentile for their age and height could be considered poorly nourished or underweight and those with weights above the 90 percentile considered overweight, and that all children between the 10 and 90 percentiles of weight could be considered well-nourished in so far as the nutritional state can be estimated from weight. In a subsequent article, Faber (2) published a table for school children similar to the Baldwin-Wood tables giving a range based upon the 10 and 90 percentiles of 60,000 observed weights for age and height.

Due to the widespread interest in nursery school children, it seems worthwhile to attempt to set up standards for preschool children similar to those of Faber and to present them

[1] The writer made this study while in attendance during summer session at the Institute of Child Welfare, University of Minnesota. She wishes to take this opportunity to thank Dr. Edith Boyd for guidance and assistance generously given.

in graphic form for practical use. The best available data for establishing such standards are those published in "Statures and Weight of Children under Six Years of Age" by Robert M. Woodbury (3). During "Children's Year" in 1918, two million records of physical examinations of children were sent by physicians to the Children's Bureau. For establishing standards of weight and height for children under six years, Woodbury selected as normal 172,000 of these records on the basis of methods of measurement, the recording of weight without clothes, absence of physical

TABLE 1

Range of variability in weight and height for age

(Adapted from Woodbury's data)

AGE*	WEIGHT				HEIGHT			
	Boys		Girls		Boys		Girls	
	10 per cent	90 per cent	10 per cent	90 per cent	10 per cent	90 per cent	10 per cent	90 per cent
months	*pounds*	*pounds*	*pounds*	*pounds*	*inches*	*inches*	*inches*	*inches*
At birth†	7.0	12.5	6.8	12.5	19.2	23.4	19.0	24.3
1.5	8.4	13.2	7.8	12.3	20.8	24.1	20.2	23.5
2.5	10.0	15.2	9.3	14.1	21.9	25.2	21.5	24.6
4.5	12.5	18.1	11.6	17.1	23.7	27.0	23.0	26.3
6.5	14.4	20.9	13.5	19.5	24.9	28.3	24.5	27.8
8.5	16.0	22.2	14.9	20.9	25.8	29.3	25.4	28.6
10.5	16.9	23.8	16.0	22.5	26.7	30.3	26.1	29.7
12.5	18.0	24.6	16.9	23.1	27.6	31.2	26.9	30.4
14.5	19.2	25.5	17.7	24.0	28.5	31.9	27.7	31.3
16.5	19.9	26.8	18.3	25.0	29.0	32.8	28.5	31.9
18.5	20.6	28.1	19.4	26.2	29.8	34.0	29.2	33.4
20.5	21.3	28.6	20.1	27.6	30.4	34.4	29.8	34.0
24.5	22.8	30.2	21.4	29.1	31.5	35.6	31.0	35.0
28.5	23.9	31.8	22.6	30.7	32.6	36.5	31.9	36.1
32.5	25.5	34.5	24.0	32.8	33.6	38.1	33.0	37.4
36.5	26.7	35.2	25.3	34.0	34.6	38.8	34.0	38.4
40.5	27.5	36.8	26.2	35.2	35.5	39.7	34.9	39.3
44.5	29.0	38.1	27.2	36.2	36.3	41.1	35.8	40.5
48.5	29.8	39.4	28.4	38.4	36.9	41.4	36.6	41.3
52.5	30.3	40.2	29.2	39.8	37.5	42.4	37.3	42.0
56.5	31.8	42.2	30.5	41.0	38.4	43.5	38.1	43.3
60.5	32.8	43.6	31.6	42.0	39.2	44.1	38.9	43.9
64.5	33.7	44.5	32.3	43.6	39.8	44.7	39.3	44.4
68.5	35.4	46.2	33.2	45.8	40.8	45.6	40.3	45.2
72.5	35.3	48.0	34.4	45.6	40.9	46.7	40.6	45.7

* Age groups are indicated by midpoints of one month intervals given in Woodbury's tables as 1 month, under 2 months; 2 months, under 3 months; etc.

† These values for weights and heights at birth are unusually high. This is probably due to the exclusion of small term infants and the inclusion of post-mature infants in the birth group.

defects, and completeness and accuracy of data.

given age and a given height as Faber did, they are adequate for determining

TABLE 2

Range of variability in weight for height

(Adapted from Woodbury's data)

HEIGHT	WEIGHT			
	Boys		Girls	
	10 per cent	90 per cent	10 per cent	90 per cent
inches	*pounds*	*pounds*	*pounds*	*pounds*
17	4.4	8.0		
18	5.1	8.0	4.6	8.2
19	5.8	9.2	5.7	9.4
20	6.4	10.0	6.3	9.7
21	7.7	11.6	7.5	11.2
22	8.7	12.6	8.6	12.7
23	9.9	14.2	9.9	14.1
24	11.2	15.8	11.2	15.6
25	12.6	17.6	12.5	17.2
26	14.2	19.1	14.0	18.9
27	15.6	20.6	15.2	20.2
28	16.9	22.0	16.7	21.5
29	18.1	23.4	17.8	23.0
30	19.5	24.8	18.9	24.0
31	20.7	26.0	20.0	25.2
32	21.8	27.4	21.1	26.8
33	23.0	28.8	22.2	28.0
34	24.2	30.2	23.6	29.4
35	25.3	31.2	24.9	30.9
36	26.6	33.1	26.0	32.5
37	27.9	34.6	27.2	33.9
38	29.2	35.8	28.3	35.2
39	30.6	37.2	29.8	36.7
40	31.9	39.0	31.0	38.2
41	33.2	40.4	32.2	40.0
42	34.8	42.1	33.9	41.5
43	36.2	44.1	35.1	43.5
44	37.9	45.7	36.4	44.8
45	39.6	47.7	38.8	47.8
46	41.2	49.6	40.2	49.7
47	43.3	51.9	41.9	52.0
48	44.9	54.6	44.7	53.8
49	47.6	54.9	46.0	56.2
50			48.5	57.5

Although the frequency tables published by Woodbury are inadequate for obtaining percentiles of weight for a

percentiles of weight for age, height for age, and weight for height. From these tables, the writer computed the

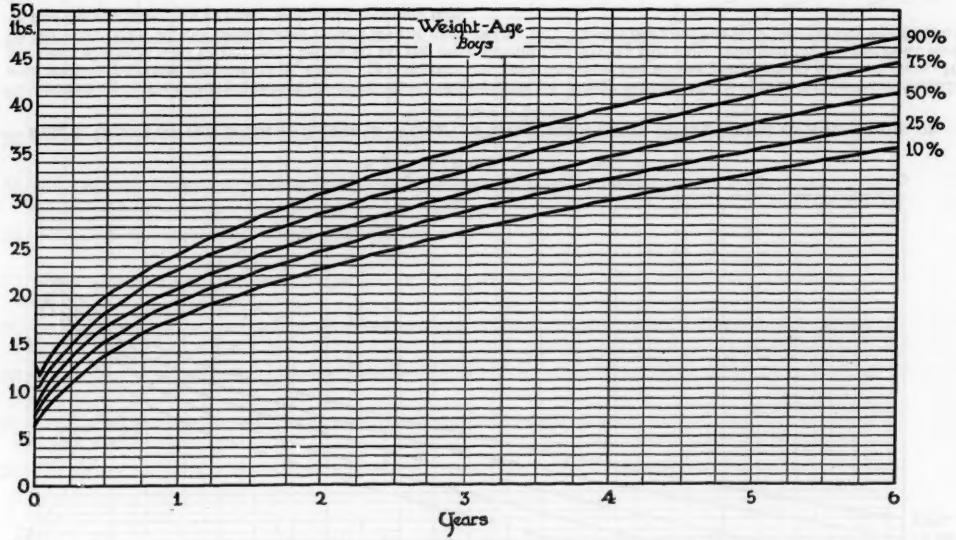

FIG. 1. CURVE OF THE NORMAL RANGE IN WEIGHT OF BOYS FROM BIRTH TO SIX YEARS OF AGE BASED ON WOODBURY'S DATA

According to Woodbury's selection of his data, the weights of 80 per cent of these children who were considered well on physical examination, should fall within the zone between the 90 per cent and 10 per cent lines, 10 per cent above it and 10 per cent below it; 50 per cent should fall within the zone between the 75 per cent and 25 per cent lines, 25 per cent above it and 25 per cent below it. The 50 per cent curve is practically equivalent to the curves based on average weight in common use.

FIG. 2. CURVE OF THE NORMAL RANGE IN WEIGHT OF GIRLS FROM BIRTH TO SIX YEARS OF AGE BASED ON WOODBURY'S DATA

According to Woodbury's selection of his data, the weights of 80 per cent of these children who were considered well on physical examination, should fall within the zone between the 90 per cent and 10 per cent lines, 10 per cent above it and 10 per cent below it; 50 per cent should fall within the zone between the 75 per cent and 25 per cent lines, 25 per cent above it and 25 per cent below it. The 50 per cent curve is practically equivalent to the curves based on average weight in common use.

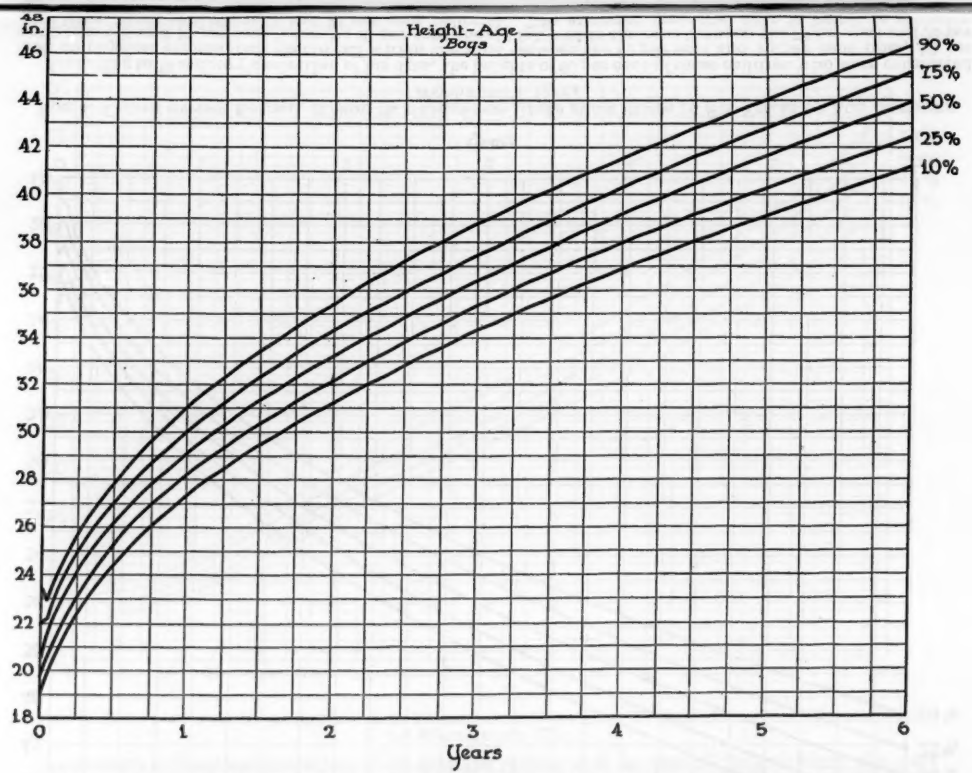

FIG. 3. CURVE OF THE NORMAL RANGE IN HEIGHT FOR BOYS FROM BIRTH TO SIX YEARS OF AGE BASED ON WOODBURY'S DATA

According to Woodbury's selection of his data, the heights of 80 per cent of these children who were considered well on physical examination should fall within the zone between the 90 per cent and 10 per cent lines, 10 per cent above it and 10 per cent below it; 50 per cent should fall within the zone between the 75 per cent and 25 per cent lines, 25 per cent above it and 25 per cent below it. The apparent neo-natal drop in height is probably due to inclusion of post-mature infants in the birth group.

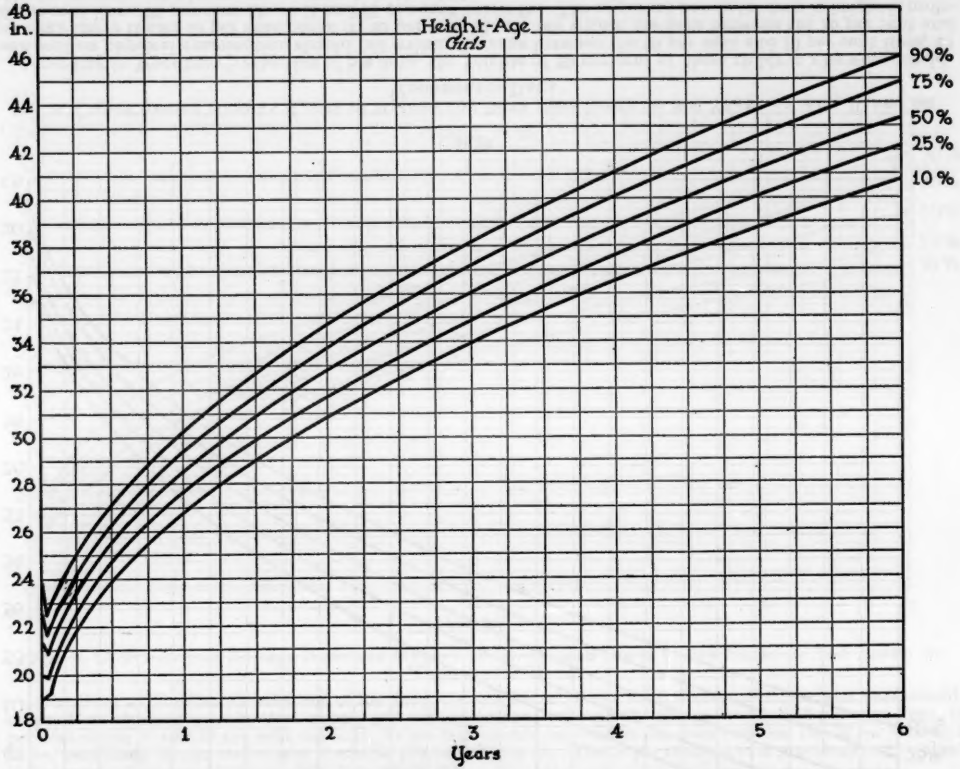

FIG. 4. CURVE OF THE NORMAL RANGE IN HEIGHT FOR GIRLS FROM BIRTH TO SIX YEARS OF AGE BASED ON WOODBURY'S DATA

According to Woodbury's selection of his data, the heights of 80 per cent of these children who were considered well on physical examination should fall within the zone between the 90 per cent and 10 per cent lines, 10 per cent above it and 10 per cent below it; 50 per cent should fall within the zone between the 75 per cent and 25 per cent lines, 25 per cent above it and 25 per cent below it. The apparent neo-natal drop in height is probably

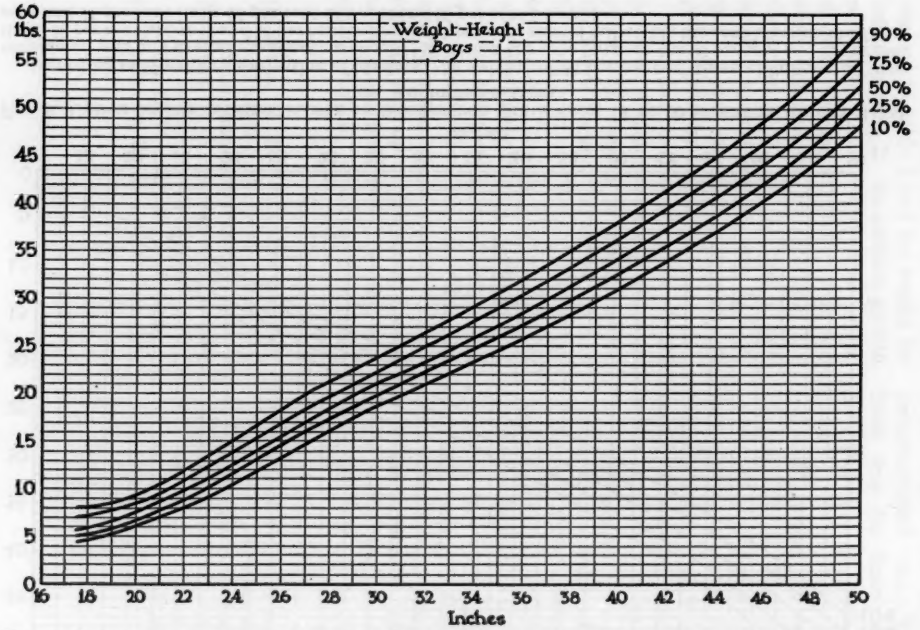

FIG. 5. CURVE OF THE NORMAL RANGE IN WEIGHT FOR BOYS FROM 17 TO 49 INCHES IN HEIGHT BASED ON WOODBURY'S DATA

According to Woodbury's selection of his data, the weights of 80 per cent of these children who were considered well on physical examination should fall within the zone between the 90 per cent and 10 per cent lines, 10 per cent above it and 10 per cent below it; 50 per cent should fall within the zone between the 75 per cent and 25 per cent lines, 25 per cent above it and 25 per cent below it.

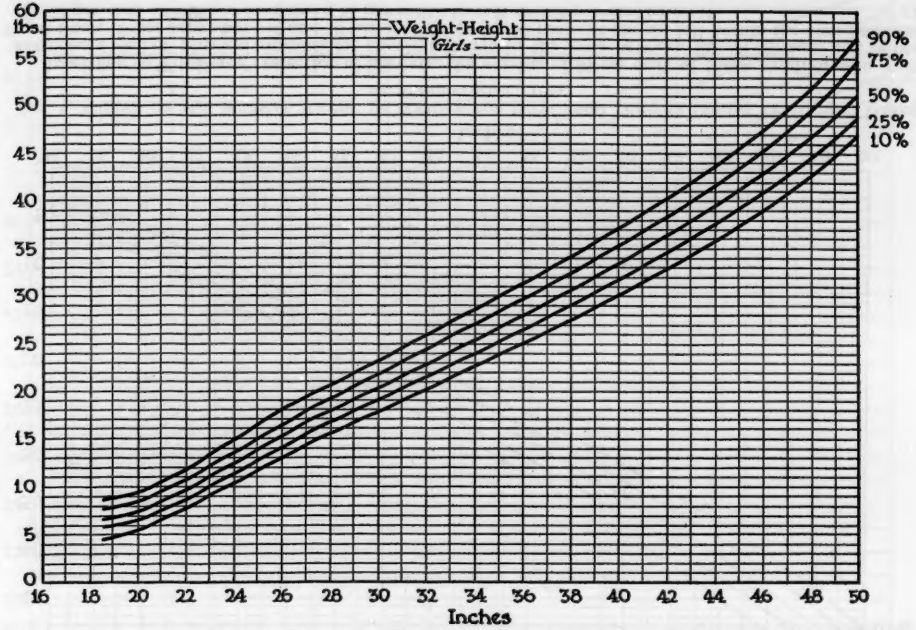

FIG. 6. CURVE OF THE NORMAL RANGE IN WEIGHT FOR GIRLS FROM 18 TO 50 INCHES IN HEIGHT BASED ON WOODBURY'S DATA

According to Woodbury's selection of his data, the weights of 80 per cent of these children who were considered well on physical examination should fall within the zone between the 90 per cent and 10 per cent lines, 10 per cent above it and 10 per cent below it; 50 per cent should fall within the zone between the 75 per cent and 25 per cent lines, 25 per cent above it and 25 per cent below it.

10, 25, 50, 75, and 90 percentiles by the graphic technic described by Yule (4). The 10 and 90 percentiles of weight and of height for age are summarized in table 1 and for weight for height in table 2. In addition growth curves of both height and weight showing normal variability with age were constructed by plotting the respective 10, 25, 50, 75, and 90 percentiles against age (figures 1, 2, 3, and 4) and smoothing the point to point curves by inspection.

According to Faber's plan, the 10 per cent of children from birth to six years with weights or heights above the curve marked "90 per cent" may be considered overweight, the 10 per cent below the line marked "10 per cent" underweight, and the 80 per cent between these two lines well-nourished. The relative position of either the weight or the height of an individual child in a group of children of his age may be estimated from the other percentile curves. In using these charts it should be noted that the child whose weight and height are both below their respective 10 percentile curves is probably a small child and not an undernourished one. The converse holds true for those above the 90 percentile line in both height and weight.

Finally, to partially compensate for the deficiency in these graphs, similar tables and graphs of weight for height were constructed (table 2, figures 5 and 6). The relation of weight to height may be interpreted from these charts in the same manner as that used in the foregoing charts.

Since these graphs define the limits of the variability in weight and height inherent in normal children, the use of them is preferable to that of curves of average weight based on the same data. However, since they give only a somewhat better approximation of the nutritional state of the child, they should not be used as a Procrustean bed of nutrition and health.

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A Study of Social Development in Early Infancy

KATHARINE M. BANHAM BRIDGES

THE studies of the social and emotional behavior of young children made by the writer (1) at McGill University Nursery School between 1926 and 1930 revealed certain trends of development which must have had their beginnings in early infancy. In order to obtain more information regarding the earlier stages in development of social and emotional behavior a further series of studies was undertaken by the writer at the "Montreal Foundling and Baby Hospital."[1]

Sixty-two infants, ranging in age from three weeks to two years were observed almost daily in the institution for a period of three months. Detailed records were kept of the children's behavior reactions and of the situations in which these occurred; special attention being paid to responses to social or emotion-producing situations. Analysis of this data made apparent certain fairly definite lines in development both of social and emotional behavior. Some aspects of the former will be discussed below; the problem of emotional development will be considered in a separate paper.

[1] The writer's grateful acknowledgment is here made to the Board of Directors of the Montreal Foundling and Baby Hospital for their kind permission to make this study, also to Miss Phillips, Miss Frazer, and other members of the hospital staff for their friendly interest and assistance in making observations.

THE INFANTS UNDER OBSERVATION

The babies for the most part lay in separate cribs, about ten in a room. They were grouped in wards roughly according to age. In one room were infants of one to three months old, in others respectively were those of three to six months, six to nine months, nine to twelve months, twelve to fifteen months, and fifteen to twenty-four months of age. The new-comers, usually about two weeks old, were kept isolated in cubicles for fourteen days for medical observation. If they were found to be normally healthy and not requiring special attention they were then placed in the wards.

During the three months that the children were under observation the same ones naturally passed from one age-group to another, some left the hospital, and new ones were brought in. Table 1 shows the actual numbers of babies observed at the different age levels.

Parents and friends visited the children on Sunday afternoons, many of them bringing rattles and toys for the babies to play with. During the week the children were accustomed to seeing only nurses in uniform and

occasionally the physician. Two or three nurses were assigned to each ward for varying lengths of time, usually about six weeks, and then a rotation was made. There were between twenty and thirty nurses in the hospital, and each of them spent some time in all the wards. They fed the babies at regular intervals, according to a time schedule suitable to the infant's age. They changed the diapers frequently, and played with the babies occasionally during the day and at bath time. The children had therefore plenty of adult attention and from a greater number of people than is usual in a private home.

For an hour or so in the afternoon, the children between nine and twelve months old were placed in a play-pen, two or three together at a time. The pen was about eight by six feet square and surrounded by a wooden railing. The babies had thus opportunity to creep about and come in contact with each other almost as soon as they were able. Older children, between twelve and fifteen months of age, were allowed to play all together on the floor of the ward for some time during the afternoons. While the nursery group, from fifteen months to two years old, played together in a large room most of the day.

One often hears it said, in pitying tones of voice, that "institution children" do not have the opportunities for development that other children have. In some respects this is true. They do not have the constant attention of one or two persons; they are not taught tricks to show off; they are not made to repeat so many times "cute little expressions." But on the other hand, they have ample opportunity for social contacts with other children and with a large number of adults.

It is more than likely that "institution children" do not develop normally in the sense that they do not grow up exactly like the "average" child, however that may be. But this does not mean that they must necessarily be subnormal in all aspects of the personality. They may be slow in speech development and even lacking in some of the common motor skills. The ideational content of their minds is bound to be limited. Their cognizance of material objects will be meagre. But their social development may be quite normal or even precocious. Their practical judgement of how to get comfortably out of a difficult situation may be exceptionally mature. Emotional experiences will be slightly different from those of the child in the home; but some forms of emotional control may be prematurely developed.

TABLE 1

Numbers of babies observed at different age levels

	NUMBER
Under 1 month	3
1 to 3 months	16
3 to 6 months	23
6 to 9 months	18
9 to 12 months	11
12 to 15 months	20
15 to 18 months	8
18 to 21 months	5
21 to 24 months	6
Over 24 months	2

In this investigation, however, the writer was not so much concerned in finding norms of behavior as in discovering trends of development. These

may be true only for the particular children studied and in the particular institution. Some of the stages of development may possibly be common to other children in different places and even of a different age. The purpose of a psychological investigation is always to find something about human behavior that will help us to predict mental processes and conduct in the same or in other individuals.

The national origins of the children were noted, but these seemed to have little or no bearing on the nature of social behavior. For the reader's interest it may be said of the babies' mothers that there were twenty-three English or English speaking Canadians, seven Irish, six Scottish, five French Canadians, four Russians, and one or two each of twelve other nationalities.

Social relations with adults

The first persons with whom the infant comes in contact are adults. Social behavior therefore has its beginnings in the relationships between child and adult. At first the people in the child's small world are intimately associated with the satisfaction of certain biological needs. Along with personal attention comes food and drink to satisfy hunger and thirst. Some adult brings about a change of position which relieves tired muscles or helps eliminate gas from the stomach. It is a grown-up who washes and sooths a clammy or irritated skin, or who makes a pleasantly stimulating rocking motion. Someone puts a shade over the sun that stings in the eyes, or tucks in the blankets that keep out the cold. In fact they are much to be desired, these large, moving objects.

During the *first two or three weeks of life* the infant seems to be quite aware of certain things which cause immediate satisfaction or dissatisfaction, for example cold wet sensations on his body, hunger, fatigue, the relief of warm dryness, the taste of food, and a change to a restful position. The child *does not pay attention to the person* who tends him, he merely appreciates the little ministrations themselves. As days go by the baby will be seen to give a fleeting glance at the approach of a person. He stops sucking to look at whoever may be feeding him, and then continues again. If a three-weeks-old infant happens to be crying from one or another form of discomfort, the mere appearance of an adult will not appease him, nor even smiles, nor songs, nor comforting words. Only relief from the particular trouble, be it a tight blanket, a sore spot on the skin, a burning hunger or what not, will stop the distressed cry.

By the time a child is *a month old* he seems to have become *aware of the presence of a person* in connection with the satisfaction of needs. It is sufficient for such a child to be picked up, for him to stop crying even before his particular little trouble is alleviated. He may be distracted from his hunger for a few moments by gentle rocking or nursing. The sight or sound of a person's approach is not reassuring enough, he continues to cry; but the *actual handling of the child* seems to bring its own satisfaction. By two months of age he may cease crying for

a moment when he hears a voice and he will smile faintly at a close and attentive person.

A *three-month-old* baby will almost always stop crying at the *sound of a comforting voice* and often at the sight of an approaching person. If the adult makes no further sign of alleviation of the child's discomfort he will begin to cry again. His interest in a person as such is still very feeble. When he is *four months old* he will smile readily at an approaching adult and will seem to take special *delight in the personal attention.* At feeding time he "wants to play," as the nurses say, smiling in response to the adult's speech and smiles instead of taking his milk. The baby is now becoming sociable. He does not seem to distinguish, however, between one person and another. Strangers and familiars are all just kindly persons to him.

About this time the child is beginning to take great delight in active play, arm-waving, pushing with the feet, exploring with the hands, shaking small objects. Feeding may come into conflict with this gradually developing interest. The person who insists upon his feeding instead of playing or smiling and cooing becomes associated with this conflict. And here comes one of the first human disillusionments. These adult creatures not only bring joy to the infant's heart and sustenance to his body, but they also appear as factors interfering with his liberty. Their insistence and coaxing are irresistible, they stand for the power of authority. The infant embarks upon the life-long problem of adjustment to authority, to mother, nurse, father, family regulations, social customs, school discipline, and so on to the end.

Four- and five-month-old children resent opposition and interference. The former struggle and the latter will even yell if anything they want is taken away. Playful attention, however, comes to be more and more appreciated. It is greeted with coos and smiles of delight; and the withdrawal of such attention is followed by fretful fidgetting, cries and grunts. The people who give most entertainment or who bring bodily comfort come to be distinguished from those who merely "pass by." *Familiar adults are welcomed* with smiles and approaching movements, while strangers are just stared at or even frowned upon.

At *six months* this last mentioned reaction is very common, and at *seven months* a baby will often *cry and draw away from an approaching stranger.* The reason for this is probably that although the visitor has similar general appearance, size, and movements to those of his nurses, the child now perceives points of difference. This person is not yet associated with the joys of drinking milk, rocking to and fro, or splashing water. Instead of drawing out playful responses the stranger merely arrests the child's attention. Only after continued acquaintance does the visitor become incorporated into the child's world, as a potential source of social pleasure as well as of tiresome interference.

During all this time, between four and eight months, the child is practicing movements and babbling sounds. He finds himself repeating his own per-

formances. He does this more often. At *eight or nine months* of age he discovers himself making an action similar to that of another person. He repeats this performance. He is actually *imitating someone else's behavior.* He may be seen for instance to nod his head or wave an arm in imitation of an adult. This is an important phase in the social adaptation of the infant. At this point begins his social training. He can now be taught to clap his hands together, turn away, shake his head and several other similar actions.

An infant of nine months, moreover, will repeat one or two easy vowel and consonant combinations after adults, such as "da-da," or "ba-ba." By *ten or eleven months* he may be heard *imitating* other *sounds* like "puh-puh" or "wow-wow." He is now learning the rudiments of common speech. He also *understands* the meaning of *certain spoken sentences* and will fit the suitable action to the sound. For instance he will hold his bottle when told to do so, or look at the toy "doggie" upon sound of its name.

Training in social behavior goes ahead rapidly at this time. The child repeats whatever brings demonstrated approval or gratifying attention and amusement. At *twelve months* of age he can perform a number of little feats of skill, pulling himself up by the chair or taking off his shoes and socks. But more important still, he will *refrain from doing certain things upon request*, such as playing with his food instead of eating, tugging at his clothes or hammering.

Speech develops less obviously, but the child repeats more of the words he hears spoken. Only three of the "institution children" could say four or five words before they were eighteen months old. But, according to Gesell, (2) babies of a year old will repeat three or four words, and those of a year and a half can say at least seven or eight words.

Two-word sentences may be heard at about *eighteen months* of age, and a definite attempt will be noticed to *convey a meaning vocally to another* person. Children will chatter to adults and other children in a confused babble, accompanied by noddings and gesture in imitation of conversation. They copy the doings of others more than ever, and run or call after adults to arrest their attention. Some will cry intermittently, others will bounce up and down or make great noise to draw attention, whichever proves most effective.

A few youngsters discover by this time (*fifteen to eighteen months*), that doing some little act of mischief, something adults try to prevent them from doing, will bring the desired attention at once. Unwittingly the adult makes it interesting and attractive for the child to become *"naughty" or disobedient.* In addition to paying prompt attention, the grown-up will often laugh agreeably at these early signs of mischief, and the child tries it again. This is not necessarily an educational blunder. A mischievous child is frequently alert and progressive. But the adult is surprised and perhaps annoyed by the rapid development of "naughtiness" in a child so young.

Strangers may still be watched apprehensively at a safe distance by an eighteen-month-old, although *fear and dislike of the newcomer* was most

striking in hospital babies of *eleven or twelve months* old. When a stranger approaches, free activity on the part of the infant is stopped, and other objects suddenly lose their appeal. The child may hide his eyes behind his hands, turn away, lie down flat or bury his head in a pillow. Interest in human beings is all-engrossing, whether it be anticipatory pleasure evoked by familiars or doubtful apprehension of strangers. Such a great variety of responses are evoked by the presence of a person, through numerous conditionings, that an enormous amount of nervous energy must be liberated upon sight, sound or feel of one. Should this person have an unfamiliar appearance or manner the old responses will be checked, and action inhibited until a further process of conditioning to the newcomer takes place.

The presence of people is thus so stimulating to the child of *fifteen to eighteen months* that his other interests are perforce subordinated for the time-being. If the little one's attention is continuously arrested by the grown-up, or if he is frequently scolded and prevented from carrying out his desires, he will *react against* the compelling force of the *ever-present or interfering adult.* His non-personal interest, his desire to explore, to handle, to bang, to shout, all assert themselves against the monopoly of the strongly developing social drive. At *eighteen months*, or thereabouts, the child offends nurses and parents by *becoming contrary* and stubborn, by refusing to do their bidding. They take it as a personal affront and say the child is getting "bad."

If these adults could but appreciate how there is, at this time, beginning in the child a tremendous internal struggle between a tendency to submit, to follow passively, and the desire for self-expression, discovery and action, they might be more sympathetic and helpful to the youngster. This very conflict implies that the child is socially highly sensitive, and yet he possesses a growing strength of character of which the parents may some day be proud. For the sake of his complete personal development the child must defend himself against continuous social influences, persuasion, and coercion.

This negativism only shows itself occasionally at first, in regard to certain specific performances or with one or another particular person. Some children show little obstinacy at all, and others do not develop stubborn reactions till later, between two and three years. As the child approaches *two years* of age he *learns to coöperate* with adults in a number of *routine performances.* He feeds himself, picks things off the floor and helps to undress himself. He accepts assistance for the most part, especially with things he could not do for himself. But he protests against anyone doing something he can do to his own satisfaction, such as holding his cup to drink from, or helping him use his spoon.

In the writer's (1) previous study of nursery school children it was noted that two-year-old youngsters seemed to be rather passive in the hands of adults. They showed little sign of negativism for a month or two; but by the time they had reached two and a half years of age they frequently

became stubborn. It is probable that these children were already growing negative at home in some respects when they first entered the school. The unfamiliar situation and strange adults at school inhibited their behavior, and the children reverted temporarily to earlier modes of response. Those who were known to chatter at home said few words at school for the first week or more. Others, who were reported as rough and noisy, appeared gentle and quiet. Gradually their school behavior approximated that of home, though always modified by the newly acquired responses specific to the school situation.

It seems certain, however, in the light of both studies, that there is a negative or obstinate period in the development of a child's relations with adults. It spreads over the age between one and a half and three and a half years. But whether it reaches its height between one and a half and two, or two and two and a half years, or even later, is a matter of individual variation.

A child's relationship with the adult, at once a kindly benefactor and a powerful authority, presents two clearly defined aspects. On the one hand is developing in the growing child a friendly interest in and a desire to imitate and coöperate with the adult. On the other hand is evolving a sense of personal identity and a desire for self-expression and assertion. The child demands more attention and at the same time less interference with his liberty. When these are incompatible he chooses one or other according to the strength of his desire at the moment. Little by little his interests increase and conform to those approved by the adult milieu. Even the most obstreperous of youngsters is a product and slave of his social environment.

Social relations with children

Babies do not ordinarily come into contact with other children until they are some weeks or perhaps several months old. Their social adjustment to young people lags behind their social response to the adult. It is true that infants lie side by side in rows of cribs in maternity hospitals, but they probably do not see each other and certainly have nothing to do with each other. The babies in the Montreal Foundling Hospital lay in close proximity to one another paying attention neither to sight, sound, nor movement of the other children for eight or nine weeks. By *two months* of age the arm, leg and head *movements of a baby* in the next crib *would arrest a child's attention* for the moment. Interest in this small moving creature would grow, and the duration of visual regard would increase from a fraction of a second to a fixed gaze several seconds long. The crying or vocalization of another child was, apparently, entirely ignored.

Only very slowly does a child develop an interest in other children. Not until he is *four or five months* old does a baby show *attentive interest at another child's cry*. He is much slower to imitate another baby's movements than those of an adult. At three months he will smile at a smiling adult but not another baby. It seems sometimes that in a ward of children from four to seven months of age, one child crying will "set off" another. Closer observation

shows that a hunger cry of other children has come to be associated with the arrival of nurse and the milk bottles at meal time. The child's own hunger is aroused and expressed in a cry similar to that of the others. It appears that a baby reaches nine or ten months before he cries or vocalizes in direct imitation of another child.

Seven- and eight-month-old babies may be seen to *smile or reach out to another* in a near-by crib. They do this usually in response to the movement of the other child and the sound of his cooing and happy vocalization. This behavior is similar to that observed by Gesell (2) in children of this age when confronted with a mirror image of themselves.

During the playful days that follow, of experimental patting, shaking and throwing, the hospital babies become increasingly interested in the antics of others. At *eleven months* and a year old they pat the bed rail or sit and *rock in imitation of each other*. During the next month or two they will be heard making similar vocal sounds and calls. By the time they are *thirteen or fourteen months* old they *laugh and smile frequently in imitation* of one another. They will even laugh and make noises to see and hear the other child laugh. Year old babies play alone for the most part, but fourteen- or fifteen-month-old children seem to like to play together in twos, suggesting frolics for each other to imitate.

When the babies are first put into the play-pen at *nine or ten months* of age, they lie and hammer with a toy, or support themselves on their hands and knees and rock to and fro. They pay little attention to each other. Almost accidentally one child pats the other instead of the floor or the rails. Such patting is ignored by the recipient, unless it is very hard and painful; then he cries helplessly. After a week or two the babies begin to *explore one another* as they explore themselves. They feel the other child's head, bite his toes, or grasp his hand. In a month or more they pat in imitation of each other, climb up by the bars or scamper laughingly one after the other along the edge of the pen, holding the top rail. Their play is already becoming socialized and mutually enjoyable.

The *ten-month-old* baby seems to be *rather indifferent when another child* in the pen *grasps his toy*. He takes hold of some other object, or sits and rocks. Children do not purposely take each other's toys at this age; they merely grasp what comes to their attention at the moment. Moreover, they scarcely struggle at all for the possession of anything. But at *eleven months or a year*, the toy a child is holding at the time comes to have a special value for him; it is his. If *another child takes it* from him *he cries*. In a few weeks' time he makes some attempt to hold on to his possessions; he struggles and squeals. He also squeals if another baby takes hold of some object he coveted, a tin lid or spools on a string.

So keen does his interest in personal possessions become that by *fourteen or fifteen months* a child may be seen to *bite and hit* the youngster who tries to deprive him of them. Biting is usually discontinued within a few weeks as a result of punishment by supervising adults. A wave of experimental biting may occur, the child trying it on adult and other children alike. This

is met with universal disapproval and achieves nothing for the infant. Hitting, struggling, and squealing when a child fails to get what he wants are more persistent forms of reaction, and continue till long after two years of age. They are often successful in procuring the desired end.

Small objects of various kinds become increasingly interesting for the *year-old* baby. He finds more and more things to do with them. He turns them upside down, pulls them apart, hammers with them, squeezes and shakes them, whether they be hard or soft. He wants more things, different things. The toy he happens to be playing with at the time has already been explored; the one the other child has arrests his attention. It has fresh possibilities. He *grabs* it. The other child, if he is the same age or a little older, *holds on to it*, resenting the interference. Then follow a brief struggle and cries from one or both sides. Along with this increasing interest in fresh toys is also developing a social interest in the other child and his activities. Thus it is that, whereas the other infant's possession has little drawing power for the ten- or eleven-month-old baby it becomes more attractive to the year-old and ardently to be desired by the still older child. Fifteen- to twenty-four-month-old children in the nursery were observed to be constantly taking one another's playthings.

It is soon discovered by the *thirteen-month-old* youngster that taking another child's toy from him produces a very marked and often exciting reaction. Interfering and *snatching playthings* is therefore subsequently indulged in as a pastime entertaining in itself. Here is a new discovery of personal power, ability to cause an effect. *The habit of interfering with others grows apace after fourteen months.* The consequences are usually highly gratifying, the drive is strong, and punishment is not very severe.

Aggressive hitting, hair-pulling, or biting for fun make their appearance after *fourteen or fifteen months.* Until then the baby's reactions on contact with another have been at first accidental and then largely explorative. The one-year-old is not so much trying to assert himself as to see what will happen. After he has discovered that something does happen, he proceeds with the same or other modes of attack. The feeling of being a cause and of controlling a situation is almost intoxicating in its delight. In spite of the nurses' scoldings and attempts at restraint the little boy or girl just goes up to another child and bangs his head. Before he is eighteen months old he discovers that hitting a smaller child is apt to cause more disturbance than hitting a bigger one. Also the former is not so liable to hit back and hurt. Thus, aggressive attacks upon the tiny or more helpless ones in the room becomes an engaging sport for the nursery child.

One or two *older children in the nursery group*, instead of hitting, taking away playthings, and generally teasing the youngest in the room, would assume a more kindly but *patronizing attitude.* They would attempt by gesture to show the little ones what to do in the matter of hospital routine, where to sit at table, or what to do with a napkin. They would sit beside the babies, pat them and pull at their

hands. Occasionally, however, even they would become rough and push the little ones over, or grab their playthings.

It must not be overlooked that there are very noticeable individual differences in the social reactions of children. Some are much more aggressive than others, some are tiresomely interfering, some are pugnacious when they are crossed, while others allow their toys to be taken away uttering hardly a murmur. One child will be quite slow getting to the stage of coveting and taking another child's plaything. One fifteen-month-old may seem quite indifferent to the others, while an eleven-month-old may laugh and frolic readily with a playmate. These individual variations are due in some measure to constitutional factors, but mostly to environmental conditions which vary for each child even in so orderly and uniform a place as a hospital.

Differences in rate and form of social development are due to variations in physical energy and health, to the pleasant or unpleasant nature of the first social contacts, to opportunity for play together with children. Some ailing babies in the hospital, for instance, were kept isolated in the sunroom for a time. Certain babies get more playful stimulation and encouragement from adults than others. Some are scolded more often, or deprived of small pleasures for disciplinary purposes. A little discipline tends to shorten the period of playful aggression and property-snatching. But, on the other hand, too much scolding and reproof often increases stubborn opposition and revengeful mischievousness. The size and age of the playmates also influence a child's social behavior and modify the developmental stages. A youngster may be aggressive and quarrelsome in a group of younger or smaller children but quite amicable and gentle with older ones.

A *developing social interest* in children as well as adults is not only *expressed* in general behavior but *in speech and language*. By *nine or ten months* of age a child repeats and imitates other sounds than his own. He has reached what may be called the stage of *imitative babble*. At *eleven months or a year*, he seems to take delight in any social response from another child to his own vocalizations. He makes more babbling *sounds for the social effect they produce*. From this age on children in the hospital were observed frequently to be jabbering nonsensically and laughing at each other.

A still later stage in the socialization of infantile language is the use of *babbling jargon to convey an idea* to another. *Eighteen-month-olds* will not only point to attract a child's or a grown-up's attention to something, but they will utter some unintelligible sounds in imitation of adult conversation. For example, one institution baby, wishing to draw a child's attention to the entrance of the nurse, pointed in her direction saying "a-gu-gu-no-ee;" another pointed to a child's spoon, uttering "babababa," meaning to say "you are not eating your dinner and you should be."

The meanings attributed to certain vocal sounds by the adults are gradually learned. The child repeats these after the grown-ups at first in the appropriate connection, then he plays

with his new vocabulary and tries the words on inappropriate occasions. He does not at first incorporate his new words into his conversational jabber with other children at the same linguistic level, but uses them only when speaking to adults. As he approaches *two years* of age the little one tries more and more to *convey a definite meaning vocally to his playmates.* He is not content with just being generally sociable. He exercises his small vocabulary of words combined with decisive gesture; and gradually the youngsters attain some degree of mutual understanding.

Vocalizations are, perhaps, in the very first instances forms of self-expression with no social reference. Though it may be said that even the earliest cries of the infant form a means of communicating physical needs to the adult. As the months go by vocalizations and nonsensical jabber are used more frequently as a means of social communication. This occurs before even the smallest vocabulary of meaningful words is acquired. Articulate speech is learned gradually as a part of social behavior and a more economical and exact means of communication.

It is true that vocalization and speech remain life-long as modes of self-expression as well as means of communication; and the more an individual participates in social intercourse the more "socialized" does his speech become. Piaget (4) has also pointed out how the language of young children is largely "egocentric" in form and reference, and that speech becomes more "socialized" both in form and quantity with advancing years. These facts, however, are in no way inconsistent with the foregoing observations on the beginnings of speech, in particular that social communiction by voice as well as gesture takes place before any skill in the use of articulate language has been acquired.

The children *between fifteen and twenty-four months* of age in the hospital nursery *appeared to unite as a group* in their behavior on certain occasions. They adapted themselves to a routine instigated by the nurse in charge. They sat quietly in a row till their names were called, refrained from handling their spoons till nurse's signal gave them permission to eat. They played more or less amicably together or separately, and readily joined in frolicsome play with the assistant nurses. But, on afternoons when the senior nurse was "off duty," the children behaved in an entirely different manner. They refused to conform to the usual routine. They cried instead of smiling at the approach of the assistant nurses. They fought and squabbled with each other, and presented the appearance of an angry, disorderly and dissenting mob. Upon the senior nurse's return they became quiet, orderly and friendly again.

This kind of behavior is similar to that observed by Isaacs (3) in the Malting House School for Young Children at Cambridge, England. It seems to confirm the theory of Freud that the primitive group held together in fraternal love and common devotion to the father or representative of the parent. The writer is not convinced, however, that the group of babies in the hospital nursery were really as united as they seemed. Each of those

children was severally conditioned to the senior nurse, so far as socially acceptable behavior and discipline were concerned. When the nurse was not present the chief conditioning stimulus for orderly behavior was absent. Accordingly the children's social behavior was disorganized. Each would have behaved in exactly the same way if he had been alone, apart from the group. There was ample evidence of this fact on many occasions. It is probable that some imitation of each other's behavior was taking place, whether it be running about or sitting still or banging with a spoon. But again this would happen no matter what sort of thing the others were doing and independently of the presence of adults.

Constant repetition of similar behavior by a group of individuals under the same circumstances no doubt eventually results in concerted action and group cohesion. The children studied by Mrs. Isaacs were between two and seven years of age. Most of them would have been members of different groups already, and would have experienced the joys of combining in action. The hospital babies were just getting together for the first time, an aggregate of individuals exposed to like circumstances in a limited space.

Mrs. Isaacs also observed her children unite together as a group bound by a common hatred or affection for one of themselves. This she believes illustrates Freud's theory of "ambivalence." The children love one another in hating the other, or hate each other in loving another. The writer has seen nursery school children uniting in attack upon an interfering newcomer and also squabbling for a seat beside a popular child. But no such behavior was observed among the hospital babies. Likes and dislikes were purely individual matters. A child might take a fancy to another and play happily with him on successive days. He might concentrate his teasing interference or aggressive attacks on one child for a time. Two children might both be teasing the same child at once. But no temporary group formed as a result of a common antagonism or affection.

Some effect of emotional contrast was observed, however, in the babies' relations with adults. The presence of a stranger would sometimes cause a child to show more than ordinary attachment to a familiar person. This was not always the case, as the children's responses were often so completely inhibited by the stranger's presence that they became less demonstrative than usual with everybody.

Generally speaking, as the babies grew week by week in friendly attachment to their attentive nurses they also became more apprehensive and resistive with strangers. This again was not true in every instance. Some showed friendly interest in all comers. Some became very affectionate and responsive with certain nurses and were merely indifferent with the others, not antagonistic. A child who always frowned and pulled away from strangers smiled agreeably at a new-comer when his mother, whose company he enjoyed, was near-by. Another child, when crying and protesting against the close presence of an unfamiliar adult, continued to grunt and squirm in disapproval even when approached by a

familiar nurse. Furthermore, after a certain age, sometimes thirteen sometimes eighteen months, the children gradually lose their apprehensive fear of strange persons in general, though their fondness for the nurses continues to grow.

Specific preferences by some of the infants for the attention and handling of certain nurses was noticeable from five or six months on. One or two cases of mild dislike were also observed. From the various observations in this respect, it seemed evident to the writer that social attachments and antagonisms arise independently, and may or may not enhance one another on any particular occasion. Whether they do or not will depend upon other agreeable or thwarting aspects of the total situation. The whole question is rather one of emotional than of social response.

CONCLUSION

In the foregoing paragraphs have been summarized the trends of development in social behavior observed in sixty-two infants between three weeks and two years of age.

Social development begins in relation to the adult. At first the adult comes to be associated with the satisfaction of various needs as a part of these agreeable experiences. Then comes cognitive differentiation and recognition of a person among other objects. Gradually an interest develops in personal attention itself apart from the pleasant associations with it. Reciprocal playful actions appear and imitative vocalizations.

Beginning as early as four or five months a conflict slowly arises between the desire for social attention and a dislike for the consequent interference with individual liberty. The child however, only feebly resents interference and makes active appeal for any personal attention. Between seven and twelve months the infant welcomes familiars ecstatically with smiles and laughter, and begins to copy their actions. But he shows definite disapproval of the presence of a stranger with whom he has no pleasant associations.

Many adults performances are imitated, and a few spoken requests may be understood and obeyed by the one-year-old. A reaction against this blind following of grown-ups sets in at about eighteen months, the child becomes obstinate on occasion and then coöperative again. He chatters conversationally in nonsensical jabber, and by two years of age he speaks with a small vocabulary of meaningful words.

Social interest in other children begins a few weeks later than interest in adults. It grows slowly up to nine months of age, then more rapidly. Year-old babies laugh and pat and rock in imitation of each other. They begin to snatch one another's toys and to struggle slightly for possession of their own. By fifteen months the infants become more combative and hit back at their offenders. Aggressive attacks are indulged in at this stage for their own sake and are not outgrown till well after two years of age.

Nine- and ten-month-old babies pat and explore the environment, including themselves, rather independently of one another. Then they imitate and amuse each other for a

few moments. Any responsive child is accepted as a playmate. But by fourteen months a child begins to show preferences. Two children will often take special interest in each other and will frolic together, or chase and tease one another. A group of three or more seldom forms, and then only very momentarily, in a nursery of babies under two years of age.

Mob behavior can be observed in a group of children between fifteen and twenty-four months of age. The children are more or less orderly, disciplined, and friendly with one another in the presence of an accepted authority. They become disorderly, refractory and quarrelsome in the absence of this personal authority. Since the children behave in the same manner individually as well as collectively with regard to their beloved and respected supervisor, it may be taken that the above phenomena are not, strictly speaking, group reactions. Repetition of such coincident and similar behavior most probably would result in time in the development of group spirit and a tendency to concerted action.

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An Investigation of Children's Use of Money[1]

ROSE L. HANSON

THE purpose of this study was to determine by experiment and by an analysis of the recorded observations in the literature what experiences are necessary to develop the concept of the place of money in the social system, and to determine to what extent a specified group of parents are supplying their children with opportunities to engage in these experiences.

Specifically the aims of this study were:

1. To determine the effect through an analysis of paired cases of (1) receiving an income according to a definite plan versus receiving an income without a well-defined plan, and (2) receiving guidance from the parents in the assumption of definite responsibilities versus receiving no guidance or overguidance by the parents without well-defined responsibilities.

2. To develop criteria for scoring parent practices in training children in the use of money, through the use of the experimental data obtained and the principles supplied by literature.

3. To make an analysis of the opportunities provided by parents for a group of children attending the College Elementary School and College High School at Cedar Falls, Iowa in grades five through twelve.

The subjects of this investigation were 202 children in the fifth through the twelfth grades of the Iowa State Teachers College Elementary and High Schools at Cedar Falls, Iowa. No attempt was made to extend this study below the fifth grade for the questionnaire showed that even in the fifth grade the children used very little money, and that unless the parents gave close supervision they had only a vague idea as to how their money was used. A more time-consuming procedure would have been necessary for the younger group in order to gain information indicative of the actual situation. A questionnaire was used to locate the children who had some money to manage.

The procedure in obtaining the questionnaire data was as follows: (1) The purpose of the study was first explained to each home room teacher in a personal interview. (2) The following preliminary questionnaire was prepared and mailed to these teachers. (3) They distributed copies among the children in their charge and suggested that they be filled out according to the printed directions. Practically every child in attendance

[1] This study was directed at the Iowa Child Welfare Research Station by Dr. Ralph H. Ojemann.

on that day handed in the desired information.

PRELIMINARY QUESTIONNAIRE

A copy of the preliminary questionnaire is given.

IOWA CHILD WELFARE RESEARCH STATION

IOWA CITY, IOWA

Miss Rose L. Hanson is making a study of children's use of money and would like to have you answer the following questions to the best of your ability.

1. Name.....
   Age..... Grade in school.....
2. Father's name.....
   Occupation.....
3. Mother's name.....
   Occupation.....
4. Do you receive a regular allowance from your parents?
5. Is this allowance paid you monthly or weekly?
6. How much do you receive?
7. How was the amount of the allowance decided upon?
8. What expenses must be met from this allowance?
9. What account are you required to make to your parents concerning your expenditures?
10. What happens in case the allowance is not large enough to meet the expenses?
11. What work do you do in the home for which you are paid?
12. What do you do to earn money outside the home?
13. What tasks do you perform at home as your share of the work around the house?

All those cases were selected in which the child either received an allowance or had an opportunity to earn money.

After eliminating certain children who were new to the community and whose families were not known to the author 90 cases remained for further investigation. These children managed money of their own and, in addition, they and their parents had been known by the interviewer for more than a year.

Webster's definition of "allowance" as a portion or amount granted for some purpose was accepted for this study. Since some families provided an allowance indirectly by arranging for the child to earn a definite wage, in the following discussions the item "Does the child have money to manage" includes both direct and indirect allowances.

INTERVIEWS

All of the interviews were held in the school building. The writer explained to the children that a study was being made of practices in the use of money. No indications were given as to whether the practices were good or bad. It was suggested that what might be a good practice in one situation might not be considered so in another. Consequently the children contributed freely such information as was requested. If there was doubt in the interviewer's mind as to the reliability of a child's statement, the question was approached from a different angle or it was asked again in the subsequent interviews or the parents were consulted.

In the interview no generalized statement on the part of the child was accepted without supporting evidence. The child was asked to relate definite things he and his parents did. The account data furnished a portion of such concrete material.

It was found that 33 per cent of the 202 children in the preliminary survey were given allowances and that 44 per cent earned money. Twenty-three per cent of the boys and 44 per cent of the girls had allowances; 61 per cent of the boys and 25 per cent of the girls earned money.

There was apparently no relationship between the amount of the allowance received and the educational progress of the child. The maximum allowance given to a fifth grade child was equal to the minimum allowance in the tenth grade. Furthermore, no relationship seemed to exist between children having money to control and the occupation of the parents.

CRITERIA FOR SCORING THE OPPORTUNITIES PARENTS PROVIDE FOR TRAINING CHILDREN IN THE USE OF MONEY

In order to develop a method for the scoring of opportunities provided by parents in the use of money, a systematic study was made of the literature dealing with the training of children in the use of money. In this article only a summary of the important points will be given.

After examining the literature together with the analytical data collected (as previously described), the following scoring units were determined:

1. Does he have money which he manages?
2. Is the money adequate for the use intended?
3. Does he have guidance in using his money?
4. Does he have opportunity to save?
5. Does he have opportunity to give?
6. Does he have opportunity to borrow?
7. Does he have opportunity to lend?
8. Does he make high grade investments?
9. Does he keep accounts (not necessarily written)?
10. Does he have home responsibility without pay?
11. Does he have opportunity to earn?
12. Does he receive his money according to a well-defined plan?
13. Does he budget his income?
14. Does he buy his own clothing?
15. Does his income increase with age?
16. Does he attend family council?
17. Do his responsibilities increase as his income increases?
18. Is his income in proportion to the family income?
19. Does he suffer for own errors in spending?
20. Does he spend according to well-defined restrictions?

In applying these scoring units to individual cases, a range of scores from 0 to 10 points was arbitrarily decided upon. However, the technique was not sufficiently refined to attempt differentiation other than 0, 5, or 10 points for each unit. (For example of this plan, see table 1.)

ANALYSIS OF SCORES

The criteria were applied to the selected group of ninety cases (fifty-one girls and thirty-nine boys). A summary of the scores follows:

SUBJECTS	RANGE	MEAN	MEDIAN
Girls	30 to 200	129.0	140
Boys	65 to 200	146.5	150
All		136.0	

Table 1 indicates the relative frequency of scores in each category. The following statements are based upon the summarized data recorded in table 1:

1. Experience in borrowing scored low. Seventy per cent of the girls and 56 per cent of the boys did not experience borrowing under parental supervision.

2. In lending, 82 per cent of the girls and 61 per cent of the boys did not participate.

3. In making investments, 43 per cent of the girls as compared to 70 per cent of the boys took an active part.

4. Earning was experienced by only 52 per cent of the girls but by 85 per cent of the boys.

5. Approximately one-half of the children budgeted their income.

6. In being responsible for clothing purchases, girls scored much lower than boys. Both ranked low on this unit.

7. Only 55 per cent of the girls and 67 per cent of the boys had increasing responsibility as income increased.

8. Girls scored some higher than the boys in giving, in keeping accounts, and in having home responsibilities.

9. In budgeting and in receiving allowance in proportion to the family income, the boys and girls shared equally.

10. Boys scored higher than girls in having money to manage, money being adequate for use intended, having guidance in the use of money, saving, borrowing, earning, receiving money regularly, clothing purchases, income

TABLE 1

Summary of the scores received by the selected group

ITEM	RECEIVING SCORE INDICATED						PER CENT RECEIVING SCORE INDICATED					
	Score											
	10	5	0	10	5	0	10	5	0	10	5	0
	Boys			Girls			Boys			Girls		
1. Having money to manage	37	2	0	42	9	0	95	5	0	82	18	0
2. Money adequate for use intended	36	1	2	45	2	4	93	2	5	88	4	8
3. Having guidance in using money	33	4	2	34	6	11	85	10	5	66	12	22
4. Saving	33	2	4	36	0	15	85	5	10	70	0	30
5. Giving	31	0	8	43	0	8	80	0	20	84	0	16
6. Borrowing	17	0	22	15	0	36	44	0	56	30	0	70
7. Lending	15	0	24	9	0	42	39	0	61	18	0	82
8. Making investments	27	2	10	22	0	29	70	5	25	43	0	57
9. Keeping accounts	16	6	17	30	3	18	41	15	44	59	6	35
10. Having home responsibility	34	3	2	49	2	0	88	7	5	96	4	0
11. Earning	33	0	6	27	0	24	85	0	15	52	0	48
12. Receiving money regularly	34	2	3	40	5	6	88	5	7	78	10	12
13. Budgeting	13	5	21	24	0	27	33	13	54	48	0	52
14. Buying clothing	16	5	18	12	3	36	41	12	47	23	6	71
15. Income increasing with age	28	3	8	34	1	16	72	8	20	66	2	32
16. Attending family council	30	0	9	36	1	14	77	0	23	70	2	28
17. Responsibility increasing with income	26	3	10	28	1	22	67	8	25	55	2	43
18. Income in proportion to family income	28	2	9	37	1	13	72	5	23	73	2	25
19. Suffering for own errors in spending	27	4	8	32	3	16	70	10	20	62	6	32
20. Spending with restrictions well-defined	35	1	3	43	2	6	90	3	7	84	2	12

increasing with age, attending family council, responsibility increasing with income, suffering for own errors in spending, spending without restriction.

SUMMARY AND CONCLUSIONS

This study aimed to determine by an analytical study of paired cases and of recorded observations in the literature: (1) what experiences are necessary to develop the concept of the place of money in the social system, and (2) to what extent a specified group of parents are supplying their children with opportunities to engage in these experiences.

Through a questionnaire a preliminary survey was made in grades five to twelve of the Iowa State Teachers College Elementary and High Schools at Cedar Falls, Iowa. The 202 children who had some money to manage were located in this way.

The important findings of the preliminary survey on 202 children are:

1. No significant relationship seems to exist between the children having money to control and the occupation of the parents.

2. No relationship between the age of the child and the granting of an allowance is evident.

3. No relationship exists between the amount of allowance received and the educational progress of the child. (The maximum allowance given to a fifth grade child is equal to the minimum allowance in the tenth grade.)

4. Thirty-three per cent of these children received allowances. (Twenty-three per cent of the boys and 44 per cent of the girls have allowances.)

In addition, units of criteria were determined for scoring the opportunities that parents provide for training their children in the use of money. These criteria were based upon the literature available and the analytical data obtained. The final scoring method included 20 items.

Application of the scoring procedure to the ninety cases studied in detail resulted in the following findings:

1. Little opportunity is provided for experiencing borrowing or lending under parental supervision.

2. More provision is made for boys than for girls to learn investment principles.

3. More boys than girls are provided with earning opportunities.

4. Only one-half of these children are encouraged to budget their incomes.

5. Parents of the children studied offer but little opportunity for the child to assume responsibility in clothing purchases. The girls share in this experience less often than do the boys.

6. The parents do not make a general practice of increasing responsibility as the child's income increases.

7. Boys are provided with more opportunities for learning the use of money than are girls.

The Efficacy of Visual and Auditory Distractions for Preschool Children[1]

LILLIAN POYNTZ

HISTORICAL BACKGROUND

AT THE present time no investigation concerned primarily with the effect of visual and auditory distractions on the performance of preschool children has yet been published. The effect of so-called distractions has long been disputed; first, in connection with their effect on reaction time and later in connection with their effect on the higher thought processes. Recent experiments have dealt with distractibility itself in relation to or incidental to other problems.

The effect of distractions on reaction time

Morgan and Evans both survey the experiments on distractions that had been published prior to 1916. Thus it remains only to survey their studies and those which have appeared since that time.

Morgan (10) was interested in the way in which a subject would react to distractions occurring while he was engaged in some task. The task was to press the one of ten reaction keys corresponding to the letter appearing in the exposure apparatus. Each of the 12 subjects had only one sitting, alternating a half hour quiet period with a ten minute period under distraction. The 9 noises, all of which were used at once, consisted of: a fire bell, a bell mechanism with hammer against a resonance box, a bell mechanism with hammer against a metal beam across the room, a bell mechanism with hammer against the table, a buzzer on the table, a bell on the left in front of the subject, a bell on the right behind the subject, a buzzer on a tin box under the table, and a buzzer on a resonance board in the left wall. A graphophone with six different records was also used. The results show that after an initial retardation, the subject in many cases exceded the speed he had acquired before the introduction of the noises. This elimination of the effects of the noises from the time records is due to an increase in effort and to the use of articulation. Less effort was expended to overcome the distraction offered by the graphophone. "Better time was made during the instrumental selections than during the humorous speeches and vocal solos, and a little better also than during the final quiet period."

Evans (5) was interested in a slightly different aspect of the problem. He

[1] From the University of Minnesota, Institute of Child Welfare. The writer acknowledges indebtedness to Dr. Mary M. Shirley who directed both the research and the analysis of the data.

presented the distracting stimuli, light from three tungsten lamps, sound from a sound hammer, and a touch stimulus made by a weight dropping on the back of the second finger of the left hand, a definite time before the slightly different light, sound and touch stimuli to which the subject was to react. In regard to adaptation, he found that, following the initial period when the time is lengthened, there is a period of adaptation but that the effect of the distractions is never completely overcome. Sound is a more effective distraction than light or touch; the distractive effect is greater when both the distraction and the stimulus belong to the same sense. In regard to transfer of training, he says that "Practice in reacting to a particular stimulus with a particular distraction aids in reacting to a new stimulus with the same distraction or to the same stimulus but with a different distraction."

Cassell and Dallenbach (3), using continuous, intermittent, and continuous-intermittent auditory distractions, in a reaction time experiment with a light stimulus, found that although distractions lengthen the reaction time, the differences being largest in the case of intermittent distraction, none of them operate constantly. Sometimes they inhibit and sometimes they facilitate, depending on the temporal relation of the distraction and on the conscious attitude of the subject during the distractions.

Dockeray (4) gives an account of Berger's experiment with four sounders tuned to different pitches and a fifth, the intensity of which could be varied, as the stimulus; a buzzer and a weak induction shock as the distractions. The distractions were continuous but only one was used at a time. "A summary of the results and the available introspection indicates two facts. First, in the great majority of cases the subject wrongly estimated his performance and the influence of the distraction, and, second, he frequently indicates directly and indirectly, that greater effort was involved." Those who thought the distractions made the test easier actually showed an increase in reaction time.

Tinker (14) is the first experimenter who ascertained "whether there is any relation between motor performance under distractions to performance in an intelligence test." Two mazes were used, a smoothed one and a notched one, for a test of motor steadiness; the distraction was produced by an electric bell ringing every time the metal stylus touched the wall of either maze. The Otis Group Intelligence Scale was given under normal conditions. The distraction, whether expected or unexpected, had little effect on the time and decreased the number of errors. The partial correlations between time or accuracy in the motor test and score or accuracy on the intelligence test were all low, some plus, some minus. Thus it is impossible to predict an individual's performance on an intelligence test by his susceptibility to this sort of a distraction.

The effect of distractions on the higher thought processes

In the concluding statement of the above article, Tinker (15) expresses the need of an experiment on the direct

effect of distraction during an intelligence test. In 1923, he published the results of such an experiment. He submitted 56 students at Clark University to the Otis Intelligence Test using 2 electric bells on different sides of the room, ringing intermittently, as a distractor. This group was given Form A without distraction and a week later Form B with distraction. A control group was given Form A with distraction and the next week Form B without distraction. He found that the range of scores in the group was more restricted with the distractor both in accuracy and in score, the better men being hindered by the distractor and the poorer men aided.

Speich (12) was interested in the effect of distractions on the higher thought processes. He performed 3 types of experiments: first, a free association test under motor and sometimes sensory distraction; second, reaction controlled by instructions to respond with, for instance, a rhyming word, a distraction sometimes present, sometimes absent; and third a free association test with, (a) instructions to react as quickly as possible, (b) instructions to react as actively as possible, under normal conditions. His results show that the more complicated and differentiated the process the more it is effected by a distraction.

Hovey's (6) study is similar to Tinker's except that more distractions were used and the control group was not subjected to them either time. His distractions were: 7 bells and 5 buzzers of various sizes and pitches, 5500 watt spotlight, 90,000 volt spark gap, phonograph, 2 adjustable organ pipes, 3 large metal whistles, 55 pound circular saw, a mounted camera operated by a well-known photographer, and 4 men, dressed grotesquely, performing stunts. Six tests from Army Alpha Form 8 were given to both experimental and control groups under normal conditions. Six weeks later the same six tests from Form 7 were given without distractions to the control group, and with distractions, as many as six of them going at once, to the experimental group. From the first part of his results, presented in table 1, Hovey concludes "that distraction is not a serious handicap to the group as a whole during nineteen minutes of concentrated thinking." E. B. Skaggs (11) takes exception to this conclusion. Skaggs used a control group working on the same material under normal conditions and found that they made a gain of 10.1 points. Thus he maintains that if the gain of Hovey's group had been more than 10.1, there would be evidence that there was an increased efficiency due to noise; if it had been the same, that noise had no detrimental effect; if lower as it actually was that "noise actually played a detrimental rôle, although it could not eliminate the practice effect." Hovey's other conclusion, that intelligence is not related to susceptibility to distractions and that there

TABLE 1

Effect of distraction on scores in Army Alpha (Hovey, p. 588)

	FORM 8	FORM 7	IMPROVEMENT
Experimental.	127.5±1.3	133.9±1.2	6.4
Control.....	127.5±1.3	137.6±1.2	10.1

are no individual differences in susceptibility to distractions, are not disputed.

Weber (16) submitted his subjects to various tests, computing, cancelling, learning nonsense syllables, solving picture puzzles, solving thought problems, answering simple questions, defining, and composing essays. Performance under normal conditions was alternated with performance under distractions, interesting anecdotes, lively music and pictures. He found that there are varying degrees of distractibility, ranging from eight per cent to fifty-seven per cent decrease in efficiency. Music was less of a distraction than anecdotes because of "the lower level of mental activity required to apprehend it."

All these experiments have been performed on adults, for the most part college students, and lead to the conclusion that distractions may inhibit or facilitate both motor and mental performance. The direction of the effect and the factors supposed to determine the direction vary with the individual writers.

Distractibility in relation to other problems

Moore and Gilliland (8) in an attempt to measure aggressiveness, submitted the 13 students rated most aggressive by the professors and students at Harvard and the 13 rated least aggressive to a series of distractions presented while they were performing simple problems in addition. Five series were given under each distraction and 10 under normal conditions. There is three times as much probability that the least aggressive person would differ when stared at as that the most aggressive would differ. Five of the aggressive resisted the distraction of an electric shock while all of the least aggressive were affected to the extent of an increase of 2.5 seconds or more. All of them showed an increase of time at the sight of a snake, but the least aggressive showed signs of panic and 8 of them delayed more than nine seconds while only 2 of the aggressive so delayed.

Hovey (7) used the same technique to measure the relation between distractibility and extrovert-introvert tendencies that he used in measuring the effect of distractions on the higher thought processes. Since the group shows less dispersion under distraction, when greater dispersion would have indicated the presence of extrovert-introvert differences, he concludes that extroverts are no more susceptible to distractions than are introverts.

Bridges (2), in her study of the occupational interests of the Nursery School children found that boys, although observed about two hours less than girls, are distracted more often, and talk more frequently, but the amount of time taken up by the different distractions is much the same for both sexes. The duration of the different distractions varied, talking taking about .5 of a minute, gazing about 1.2 minutes and wandering about 1.7 minutes; the boys worked 2 minutes between distractions and the girls 3 minutes. In most cases the distractions were distributed evenly through the observation period.

In Bott's (1) study of the play activities of Nursery School children, she considered that the child's atten-

tion was occupied solely with the material in hand unless he stopped playing with it for a full minute. Although records were kept of the conversation and of the periods of watching others, no indices of distractibility are computed from these. She found, however, that the length of time a child is occupied with one thing increases with age; viz., "2.5 minutes for 2-year-olds, 4.7 for 3-year-olds, 5.6 for 4-year-olds, and 3.8 for those ages together."

Moore (9) in a recent study at Iowa, was very fortunate in devising a task of great intrinsic interest to young children. The subjects were asked to deliver some toy oranges from one corner of the room to a house in the opposite corner by loading them on a train and pushing it along a track. The toys used for the distractions were a doll, a ball, some blocks, a flicker top, and a toy xylophone. Placing them on the track and asking the child whether he wanted to play with them or not is a new method of introducing distractions. She found wide variations in the manner in which the children reacted to the toys. The correlations between the time spent on the various distractions are low. Those between the experimental score (the time on errand divided by total time) and chronological age and mental age, and teachers rating are low also, ranging from −.04 to .35.

Summary

Distractions may either inhibit or facilitate both motor and mental performance. The facilitation is probably due to an increase in effort on the part of the subjects. Studies on distractibility itself reveal no conclusive evidence of its relationship to any traits of temperament. In the investigations on preschool children observations on distractibility have been incidental to the major problem and thus no conclusive results have been reported.

METHOD

Purpose

This investigation was carried on with the purpose of studying the susceptibility of preschool children to visual and auditory distractions while performing a standard task.

TABLE 2

Age and socio-economic distribution of subjects

AGE DISTRIBUTION		SOCIO-ECONOMIC DISTRIBUTION	
Months	Number	Classes	Number
26 to 42	14	I	6
43 to 54	14	II	4
55 to 66	12	III	14
		IV	11
		V	5

Subjects

The 40 children in the Nursery School and 7 in the Kindergarten of the University of Minnesota who served as subjects had an age range of from twenty-six to sixty-six months with a medium age of 43.5 months. Their I.Q.'s ranged from 90 to 131 with a median I.Q. of 106. Their distribution according to age in month intervals and according to socio-economic status is shown in table 2.

Description of the materials

A peg board, 10 by 12 inches, with twenty three-fourth-inch holes was used as a standard task. Two boards, one red and one green, with five sets of 2½-inch pegs, purple, blue, yellow, green, and red, were used.

The auditory distractions consisted of a metronome for an intermittent stimulus and a toy victrola for a continuous stimulus. The victrola played a record of "Sing a Song of Sixpence." The intermittent visual distraction was a 60 watt light which flashed off and on 60 times a minute. A group of toys were exposed as the continuous visual distraction. The toys, a doll, a shaggy white dog, a bridge of A-B-C blocks, a tower of nested blocks, and a toy xylophone with a white rabbit climbing onto it and a monkey sitting in it, were arranged on a chair on the opposite side of the table from the child. On the wall above the back of the chair were 2 pictures, one of a little boy and girl at lunch and the other of a laughing baby. A grey screen concealed these objects and pictures from the subject except when they were presented as the distraction.

Directions and procedure

The child was seated in a small chair at a low table directly in front of the screen. The green board was always on the table in front of the chair and the box of purple pegs at the side of the board at the right of the child. He was told, "Pick up the pegs and put them in the board as fast as you can." Five trials a day were given for 5 consecutive days, except when absences or holidays intervened. The first day the trials were as follows:

1. Green board	Purple pegs	No distraction
2. Red board	Blue pegs	Metronome
3. Green board	Yellow pegs	Toys
4. Red board	Green pegs	Victrola
5. Green board	Red pegs	Flashing light

The order of presentation of the pegs and boards remained the same every day but the order of the distractions rotated; each day the last one of the day before was presented first.

Stock answers were given to the constantly recurring questions:

Metronome and victrola

"What's that?" (1st day)	"I'll show you when you finish putting in the pegs."
"What's that?" (2nd day)	"You know what that is; you saw it yesterday."

Toys

"Why did you move it?" (the screen)	"I thought you'd like to see those things."
"Are they to play with?"	"You may play with one when you finish."
"Why did you put it back?"	"I thought you might get tired of looking at them."

Flashing light

"What makes it go?"	"It's made that way."
"Quit making it go."	"It will stop when you finish."

All

"Do it again."	"Not this time."

Motivation

The distractions themselves acted as incentives. Such remarks as "I'll hurry so I can play with them" were frequent in reference to the toys. The first day especially in the metro-

nome and victrola situations they would hurry so they could see what was making the noise. Some of them were so annoyed by the light that they would hurry so they could turn it off.

Unintentionally another spur to putting the pegs in faster was introduced by the fact that while the child was filling one board, the experimenter had to remove the pegs from the other. "I'll beat you" was perhaps the most frequently made comment. Elise made the following quaint remark repeatedly, "You take some out but leave a few in so I can beat you."

On the third day by way of special incentive, each child was told he could make a little peg board to take home with him. He chose the color he wanted from some varicolored pieces of drawing paper and if he was strong enough to work the little hand punch he punched the holes in it himself. In case the punch was too hard for him to press, the experimenter punched the holes but the child always put the pegs in. The pegs were matches with their heads burnt and scraped off and painted various colors. A few holes were punched after each trial and the "birthday cake" as most of them called it, was not finished until the last day.

The children enjoyed the "game" as it was called so much that often it was more difficult to get them to leave than to get them to come. As long as six weeks after the last experimentation some of them were still asking the experimenter if they might come play with her.

Method of recording

For each trial the time in seconds, the number of times the child looked up from the task, and the comments he made were recorded. The time was read from a stop watch started at the time the first peg was placed and stopped when the last one was placed. The look-ups were recorded simply by making a vertical line in the appropriate column every time the child glanced up from his task regardless of what he looked at. The majority of the glances were directed toward the distractions, occasionally toward the experimenter or around the room. The comments as far as possible were recorded verbatim. As soon as the record for a single child was complete, the number of words spoken during each trial and the number of ideas expressed were counted. These and the number of ideas referring to each of the four topics, experiment, distraction being presented at the time, another distraction, and irrelevant were tabulated under each distraction.

Sources of error

The greatest source of error lies in the fact that sometimes it was impossible to record every word the child said either because of the length and rapidity of his comments or because of the difficulty of understanding baby-talk. In such cases the experimenter counted the number of words and designated by a symbol the content of the idea expressed. Minus meant that the comment was totally irrevalent, zero that it referred to the experiment, plus that it referred to the distraction being presented at the time, and double plus that it referred to one of the other distractions.

The data thus obtained lend themselves to the comparison of the effects of visual and auditory distractions

and to the study of individual differences in distractibility.

POTENCY OF THE FOUR DISTRACTIONS

The effect of each distraction was measured in 4 ways: its effect on the length of time required to complete the task, on the number of times the child looked up from the task, on the number of words he said, and on the number of ideas expressed in his conversation. Each child was given a percentage score for each item for each distraction. These scores were computed by getting the per cent that the raw score for each item was of the corresponding item on the standard task presented without distraction.

Consistency of the record taking

The reliability of the experimenter's records was obtained by having an unseen observer watch the children and record the time and look-ups simultaneously with the experimenter. Since the observer could not hear the comments no check could be made on them. For the time scores, 23.6 per cent were in perfect agreement, 56.9 per cent differed by less than three seconds, while only 6.9 per cent showed a difference over six seconds. Thus an error of 2.3 per cent is involved in the experimenter's time records. This was obtained by getting the per cent that the sum of the differences between the two records was of the total time as recorded by the experimenter. As for the number of look-ups, perfect agreement occurred in 29.6 per cent of the cases, a difference of only one in 52.1 per cent, a difference of two or three in 14 per cent, and a difference of more than three in only 3 cases. The per cent of error involved in the number of look-ups, obtained by the same method, is much larger, namely, 23.8 per cent. This would seem that the experimenter recorded too few look-ups but the number of plus and minus differences was exactly equal.

Distractions

The 4 distractions were found to differ markedly in their effect on the children, regardless of which measures of distractibility was used.

Time

The average time scores for all children are given in table 3. The average length of time for the performance of the standard task was seventy-one seconds per board or three hundred and fifty-six seconds for the five presentations. For both the metronome and the victrola the average time scores were reduced, to 98 per cent for the former and to 97 per cent for the latter. For both the toys and the light on the other hand the time scores were increased to 108 per cent and 105 per cent respectively. So far as time goes the auditory distractions are facilitating, but not to as great an extent as the visual distractions are inhibiting, since the average of all the distractions taken together is 102 per cent of the standard. The two auditory distractions are about equally potent, but the toys exceed the flashing light in potency.

Look-ups

On the average the children's eyes wandered from the standard task only twice for each board, or 10.4

times for all presentations. (See table 3.) All distractions increased the child's tendency to look up. The metronome and victrola were again almost identical in their effect on the children's response, and likewise they were much less efficacious than either of the visual distractions. In look-ups as well as in time the toys had greater attention value than the flashing light.

Number of words

Distractibility as measured by the total number of words in the child's conversation is also presented in table 3. The children average sixteen words per board on the standard task or 81.6 words on all of them. Both auditory distractions inhibited conversation, the metronome reducing it to 85 per cent of the standard and the victrola to 50 per cent. The discrepancy between the two is probably explicable by the fact that the children remained quiet in order to listen to the song. Frequently they even asked to hear it again. Under both the visual distractions the children became more voluble. The greater interest in the toys was again shown by the greater amount of speech they called forth.

Number of ideas

The method of counting ideas is rather unique. Frequently a child talked for several sentences on the same topic. It is difficult to know whether a long continued conversation on the same topic is indicative of concentrated attention or of distraction. Flight of ideas, however, would seem to be a true indicator of distraction. Consequently a new idea was counted only when the child changed from one topic to another.

In general the children broached only 1 topic per board under standard conditions or 5.4 for all presentations. (See table 3.) The metronome called forth slightly more ideas than the standard in spite of the fact that fewer words were used during this situation.

TABLE 3

Effect of distractions on the four measures

	TIME		LOOK-UPS		WORDS		IDEAS	
	Raw score	Per cent score	Raw score	Per cent score	Raw score	Per cent score	Raw score	Per cent score
Stand	356.0	100	10.4	100	81.6	100	5.4	100
Metronome	347.5	98	13.8	132	69.3	85	6.5	120
Victrola	343.7	97	13.9	134	41.2	50	5.2	96
Auditory	345.4	97	13.9	134	55.2	68	5.9	109
Toys	385.2	108	19.4	186	105.2	129	7.8	144
Flash	375.0	105	17.4	167	89.9	110	7.5	139
Visual	380.1	107	18.4	177	97.5	119	7.7	142
All distractions	362.7	102	16.1	155	76.4	94	6.8	126

This is to be expected, however, in view of Sundberg's (13) finding that a crowded room evokes more words in a free association test than does an empty room. The addition of the metronome simply added one more topic of conversation.

The victrola limited the number of changes from one topic to another. This is consistent with the effect of the victrola as measured by the other criteria. The toys and the flashing light maintained their inhibitory influence on performance by evoking more ideas than the standard task did. As a whole the distractions tend to make the children jump from one topic to another, devoting comparatively few remarks to each.

Content of comments

A knowledge of the proportion of ideas pertaining to the distractions is pertinent in determining their effect on the child's conversation. A study of the comments revealed that they fell naturally into three categories with a small number of *irrelevant remarks* which varied from "I have a new dress" to "My father takes me to work with him on Saturdays." The first category was *comments pertaining to the experiment itself*; such as, "I'm building a barn, these are the horses coming out." or "Are all the pegs here?" The second included *remarks referring to the distraction being presented at the time* such comments ranged from "What's that?" to "Oh, a doll, she's got hair, and a hair ribbon. Can I play with her? And blocks. And what's that? Can I play with it, too? She's a nice doll. I've got a doll, she has a blue dress." Although the latter comment actually contains many ideas, since they all referred to the one topic, it counted as only one idea. Finally there were *remarks referring to a distraction other than the one being presented at the time.* For instance, in the metronome situation, the child would say "Turn on the light" or "Why don't you play the victrola? When will you play it again?"

The percentages under each of these categories are given in table 4. These percentages are based on the total number of ideas expressed by the whole group. In terms of the ideas expressed the victrola demanded more attention for itself than did any of the other distractions. This was to be expected in view of the small number of words used in that situation. The majority of the children would say, "What's that?" or "Is that the blackbirds?" and sit quietly until they finished putting in the pegs. The consistency of the per cents is surprising. Under each distraction about 45 per cent of the comments pertained

TABLE 4

Effect of distractions on content of comments (expressed in percentage of total number of ideas)

	DISTRACTION	EXPERIMENT	OTHER DISTRACTIONS	IRRELEVANT
Standard		72.4	9.3	18.2
Metronome	42.1	40.9	5.4	11.6
Victrola	53.1	30.1	6.7	10.0
Toys	45.2	35.9	6.7	12.2
Flash	45.5	34.6	7.3	12.6

to that distraction, about 35 per cent to the experiment, about 7 per cent to another distraction, and about 12 per cent were irrelevant. In the standard more than 70 per cent were about the experiment and a greater number were irrelevant.

Summary

In general the toys and flashing light are more potent distractions than the metronome and victrola. The two auditory distractions facilitate the performance of the standard task from the standpoint of time and reduce the volume of speech. Both the visual and the auditory distractions lessen the amount of visual attention to the task. All the distractions except the victrola increase the fertility of the children's ideas.

AGE, SEX AND SOCIO-ECONOMIC DIFFERENCES

Age differences

A similar analysis of the data on the basis of the three age groups revealed that although time, number of look-ups, number of words, and number of ideas decreased with age there is no similar decrease in the efficacy of the distractions as measured in percentage. This indicates that susceptibility to distractions is not dependent on age. In each age group the results are consistent with those obtained for the group as a whole. The toys and flashing light are just as much more potent than the metronome and victrola at the 3-year level as at the 4-year or 5-year level.

The proportion of the comments referring to the distractions being presented at the time increases slightly with age at the expense of comments on the experiment; the proportion referring to one of the other distractions or irrelevant is about the same at each age level.

Sex differences

When analysed on the basis of the sex groups the data become extremely ambiguous. In view of the fact that there is absolutely no difference on the basis of time, it is of some significance that the boys looked up 10, 20 and 30 per cent more than the girls. That is the boys' visual attention to the task was much less than was the girls'. Furthermore, the boys became much more voluble under the influence of the distractions than did the girls. On the other hand, the girls showed a greater variety of ideas. Thus the differences which did appear are not consistent; but the bulk of the evidence supports Bridge's finding that boys are more distractible than girls. The lack of clear cut differences again indicates that the test is measuring the potency of the distractions, a property independent of either age or sex. At any rate for all ages and both sexes the toys and flashing light are much more potent distractions than the two auditory ones. The metronome and victrola consistently caused less disturbance and sometimes actually facilitated performance.

Socio-economic differences

The number of cases in the different socio-economic groups is small even though they are fairly proportional to the numbers in the population in Minneapolis. Susceptibility to dis-

tractions is not a function of the socio-economic status of the parents of these children. The tables are very similar to those for the group as a whole and to those showing the age and sex differences. They reveal no definite increase or decrease as you go up or down the occupational scale. Every measure, however, except the number of ideas under auditory distraction gives some indication that the upper three groups are more distractible than the two lower groups. This may mean that the children from the higher classes notice more of their surroundings and have more curiosity about them. In every group by every measure the same tendency for the auditory to be less disturbing than the visual distractions is present. The analysis of the content of the comments showed about the same per cents pertaining to the four general topics that were found in the age and sex tables.

INTERCORRELATIONS AMONG THE DISTRACTIONS

Individual scores on every distraction were computed by converting the raw score for each into a percentage of the standard. This was done for each measure of each distraction. Correlations were then computed by the rank difference method on the basis of these percentage scores.

Intercorrelations between the four measures, using the combined scores for all distractions, are presented in table 5. Look-ups are unrelated to any of the other measures of distractibility; but there is a fair positive relationship between distractibility as measured by time and distractibility as measured by number of words, and by number of ideas and between distractibility as measured by ideas and that as measured by words.

Intercorrelations between the degree of distractibility during the two auditory, the two visual, the two continuous, and the two intermittent distractions as measured by the four criteria are presented in table 6. Time seems to be the least consistent measure from distraction to distraction and ideas the most consistent measure of distractibility. The metronome and victrola are the most similar in the effect they have on the time and number of look-ups, and the metronome and flashing light most similar in effect on the number of words and ideas. All coefficients are positive and of fair size. To be sure the four distractions do not influence

TABLE 5

Intercorrelations between the four measures—all distractions combined

	TIME	LOOK-UPS	WORDS
Look-ups	−.01		
Words	.56	−.10	
Ideas	.24	−.28	.48

TABLE 6

Intercorrelations between the distractions

	TIME	LOOK-UPS	WORDS	IDEAS
Auditory: Metronome with Victrola	.47	.53	.45	.56
Visual: Toys with Flash.	.24	.45	.42	.47
Intermittent: Metronome with Flash	.40	.47	.51	.61
Continuous: Toys with Victrola	.26	.39	.35	.38

a given child equally; but there is a general tendency for distractibility to one type of stimulus to go with distractibility to another.

Intercorrelations between the different measures for each distraction were then computed. These coefficients, table 7, show that there is little or

TABLE 7

Intercorrelations between the different measures for each distraction

	METRONOME	VICTROLA	TOYS	FLASH
Time with Look-ups.	.18	.29	.10	.17
Time with Words....	.26	.59	.60	.42
Time with Ideas.....	.24	.27	.12	.34
Look-ups with Words.	.03	−.04	−.18	.04
Look-ups with Ideas.	.10	−.23	−.32	−.05
Words with Ideas....	.44	.58	.37	.49

TABLE 8

Intercorrelations of composite scores on distractions

	METRONOME	VICTROLA	TOYS	VISUAL
Victrola.....	.58			
Toys.....	.40	.32		
Light.....	.52	.24	.24	
Auditory.....				.55

no relationship between the different measures. The highest, as was to be expected, are between time and words and between ideas and words.

This suggests that distractibility is a composite trait. In order to get a total distractibility index a score must be computed which takes all four measures, time, number of look-ups, words and ideas into consideration. The former studies on the effect of distractions have considered only differences in time between performance under distraction and performance under normal conditions. Thus the sums of the percentage scores in all four measures for each distraction and for the two auditory combined and the two visual combined were obtained and intercorrelations between the different distractions computed. (See table 8). These coefficients are no higher than when each measure is correlated separately. A composite score is no better measure than a single criteria. This means that the child does not react in the same manner to any two distractions. The child most affected by the toys may or may not pay attention either visually or verbally to the victrola or even to the flashing light.

As was to be expected the correlations with C.A. showed a negligible relationship, sometimes positive and sometimes negative. In general the coefficients reveal the same tendencies that the analysis of the data on the basis of age differences showed.

These same measures, when correlated with the I.Q.'s obtained for each child by the Minnesota Preschool Scale, give mostly small negative correlations. This is in agreement with Hovey's conclusion that intelligence is not related to susceptibility to distraction. It does appear that the more intelligent child notices what is going on around him and pays more attention to it and is thus more distracted by it than the less intelligent child.

The correlations between the distractions and age and intelligence bear out the statement that distractibility is to a certain extent a personality trait, relatively independent of other factors. The low intercorrelations between different measures of distractibility and the fact that composite scores correlate no more highly may suggest unreliability in the method. It seeems more likely, however, the distractibility is not a constant trait, but that it is to a large degree dependent on the child's mood or whim at the moment. The low correlations of the various measures are to be interpreted at least in part as indicating that different types of distractions are reacted to in different ways. Visual objects are looked at whereas a victrola record is listened to.

CRITICAL EVALUATION OF THE METHOD AND RESULTS

That the standard task method is adequate for determining the effect of various distractions is evident from the consistency of the results. To measure individual differences in distractibility, however, the method is quite inadequate. A distractible child may be as distractible one day as he is the next but he is not distracted to the same extent by the same things.

Difficulties of the standard task method

For most distractions negative adaptations sets in and they are no longer noticed. Thus it is impossible to secure enough measures on a child to be truly representative of his degree of distractibility, because a young child's interest dies quickly if his task is repeated too often. One might think that 20 days would yield a better measure of distractibility than 5 days. At the end of 5 days, however, the children had begun to say, "You do the same thing every day. Can't we do something different?" They were also guessing which distraction would come next. This showed that the distractions had lost their novelty and that interest had shifted from the distraction being presented at the time to the one coming next.

In any study of distractions, a strong motivation is needed to make the subject do his best every time. Otherwise, the individual's score is affected by his lack of attention to the task as well as by his attention to the distraction. Such motivation would be totally lacking in a reaction time experiment on preschool children. In mental tests experiments, arithmetic or group intelligence tests, which could be used as standard tasks for measuring the distractibility of adults or older children, the motivation is largely derived from extrinsic sources, such as verbal instruction, rivalry, and competition. These tasks cannot be used with preschool children nor can these motives be applied in an individual situation. Verbal motivation is ineffectual with young children because it makes the directions more complicated and harder to understand; and rewards soon lose their value. The task, then, should be intrinsically interesting. The peg board meets this requirement for only a short time; thereafter interest wanes. Moore's task of delivering oranges was very effective but it was used only twice on each child. The ideal experiment

would consist of a battery of tasks, a dozen or more, each of which is as interesting as the peg board or the orange delivery situation were the first time they were used. The objections to this are devising twelve tasks of the same interest and of the same difficulty. Unless the tasks could be perfectly equated it would be impossible to compare the efficacy of the distractions from one task to the other. The alternative to the standard task method is the time sampling method.

Odd-even correlations

Even though a given child is usually more distractible than the others of a group, he varies from day to day. The degree of distractibility displayed at any one time depends to a great extent on the mood or whim of the moment, possibly on the events immediately preceding the observation.

Thus the usual method of computing the reliability of a test falls down because the value of a given distraction fluctuates from time to time and because of the impossibility of securing enough measures. The odd-even coefficients for the raw scores, as raised by the Spearman-Brown prophecy formula, are given in table 9. These show a fair degree of reliability or consistency for the measuring device. The coefficients were computed for the metronome and toys only because there was no reason to believe that they differed from the others. When the ratios are used, however, the method becomes totally valueless (see table 10) regardless of whether time or look-ups is the measure of distractibility. These low coefficients are due in part to the fact that a given child differed in his performance of the standard as well as in his performance under distractions. Small differences in either one make great differences in the ratios.

Teachers' ratings

A further proof that this method is not applicable for measuring the distractibility of individual children is the lack of relationship between teachers' ratings of distractibility and distractibility as measured by this method. Ratings were obtained from four Nursery School teachers on 28 of the children by the paired comparisons method. Each child was compared with each of the 27 other children and rated as more or less distractible. The scores for each child were weighed, 1 for each M under his name, −1 for each L. Thus if all the teachers agreed on any one judgement, the score was 4 or −4. If 3 agreed and 1 differed, the score was 2 or −2; if 2

TABLE 9

Odd-even reliability for raw scores. Time —2nd and 4th with 3rd and 5th trials

	5 YEARS	4 YEARS	3 YEARS
Stand	.87	.63	.91
Metronome	.93	.70	.91
Toys	.93	.50	.73

TABLE 10

Odd-even reliability for the ratios

	TIME	LOOK-UPS
Metronome	−.08	+.01
Toys	+.09	+.15
Flash	−.02	−.09

said more and 2 said less the score was zero. The scores for each child were then added algebraically. The least distractible child scored −102, the most distractible 90. The children were ranked on the basis of these scores and these were correlated with their distractibility scores. The teachers agreed perfectly in 49.43 per cent of the 756 judgments, 3 agreed and 1 differed in 34.79 per cent of the judgments, and in 15.87 per cent, two rated the child more and two rated him less distractible than another. The coefficients are presented in tables 11 and 12. Moore also found no relation between teachers' rating and her measure of distractibility.

TABLE 11

Correlations between teachers' ratings and composite scores

Metronome	−.06
Victrola	−.16
Toys	−.16
Flash	+.10
Auditory	−.14
Visual	−.04

TABLE 12

Correlations between teachers' ratings and the four measures all distractions combined

Time	−.04
Look-ups	−.24
Words	−.06
Flash	.00

Theoretical implications

It is of some theoretical importance that music, which has been found by other investigators to facilitate behavior, was found to have a facilitating effect on the preschool level. There may be natural rhythm in the organism which is brought out by the music or the facilitating effect may be due to negative adaptation to various noises beginning in early infancy. Children in this age soon become adapted to noises of all kinds, the radio, doorbell, hucksters, trains, automobiles, and even airplanes.

There are a few implications, furthermore, which might prove of some practical value. If a mother has a definite task for her child to do, or if during such tasks as eating, bathing, dressing and undressing, she turns on the radio or victrola she will get much better results; also if there are no toys or other interesting objects in sight with which he would want to play. Of course it is well for a child to be able to concentrate on what he is doing in spite of distractions. Perhaps the only way to attain a high degree of concentration is by building it up through practice in doing things while disturbances are going on.

DISCUSSION

These results are in line with those obtained from the studies on reaction time, especially with Morgan's conclusion that the effect of auditory distractions is eliminated from the time records and with Evans' that the distractive effect is greater when both the stimulus and the distraction belong to the same sense. Herein lies the reason for the great increase in time caused by the visual distractions. The children could not continue putting the pegs in while looking at the toys or the light but it was easy to put them in and listen to the victrola or metronome at the same time. Evans found that sound is a more effective

distraction than light or touch while this study indicates that light is more effective. Here again the potency of the distraction seems to depend on the nature of the task to be performed under that distraction. The other investigators found that every distraction sometimes inhibits and sometimes facilitates performance and that is truly what happens. These results corroborate Tinker's lack of relation between intelligence test scores and time and accuracy scores on a maze learned under an auditory distraction. They also lend support to Hovey's conclusion that intelligence is not related to susceptibility to distraction. This study also confirms Moore's finding that the relation between the time spent on one toy with the time spent on any other one is negligible, and that distractibility as measured by her method is not correlated with teachers' ratings of distractibility.

CONCLUSIONS

1. Visual distractions have a much more disturbing effect on the performance of a simple motor task which involves visual attention, than do auditory distractions when the effect is measured by the increase in time, in the number of look-ups, in the number of words, and in the number of ideas in the experimental as compared to the standard situation.

2. So-called auditory distractions actually facilitate these preschool children in the performance of the task. Less time is required, and fewer and shorter comments are made under these distractions than under standard conditions. The increase in the number of look-ups is much smaller for the metronome and victrola than for the toys and flashing light.

3. The susceptibility to distraction as studied in this experiment is a trait independent of sex, chronological age, I. Q. of socio-economic status.

4. The effect of the four distractions not only varies from child to child but also from time to time in a single child.

5. The standard task method is adequate for determining the effect of various distractions; but it is not adaptable to the study of individual differences in distractibility.

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A Study of Handedness, Eyedness, and Footedness

MARY B. EYRE AND MARY M. SCHMEECKLE

ALTHOUGH work has been done on the correlation of eyedness and handedness little has been published on correspondence of the foregoing with footedness in the human subject. There is a study by William Schott (5) in German, as yet untranslated, comprising group tests on handedness and footedness, presumably of adults. Haefner's (3) study of 136 elementary school children, fourth to seventh grades inclusive, makes a comparison between correspondence based on the total results of a battery of eight activities which are assumed as tests for handedness, with the total results of a battery of four assumed tests for footedness. He concludes that a marked degree of foot dominance appears only in a small number of children; and that "unimanual activities are rather highly correlated with the foot act of kicking and pressing down, but show less correspondence for stepping up and off." Haefner's conclusions would seem to raise the question of the value of the various activities as criteria for dominance.

This report is based on work which was undertaken as part of a program at Claremont Colleges under the direction of the writers. Tests for eyedness, handedness, and footedness were made at Memorial Junior High School on 200 students whose visual acuity was normal (i.e. $\frac{2}{2}^{0}$ by Snellen Chart) and on 80 additional cases having defective vision. There were 111 girls and 169 boys; the ages ranging from eleven to eighteen years. An effort was made to eliminate as far as possible the factor of training. Tests were given so as to appear to the child as part of the routine health examination with which in general children are already familiar.

Materials used were as follows:

1. Snellen eye chart.
2. Paper Frustrum of a cone. Size: Slant height 3¼ inches, small diameter 1¼ inches, large diameter 2¼ inches. Weight: 5.95 grams.
3. Adhesive Roll: Size: Height 3½ inches, diameter 2¼ inches. Weight: 272 grams.
4. Notebook and pencil for students' signatures, routinely used in nurses' office.

METHOD OF PROCEDURE

The fixation test was used for eyedness. Rechecks of 100 subjects were made with Parson's Manoptoscope showing non-correspondence in only 2 cases, which were thereupon discarded. Handedness was determined by pointing, and rechecked by writing. The subject, S, was asked to point at a specified letter on the Snellen Chart. As this was part of the

fixation test S regarded it as related to his vision. The use of his hand was therefore less conscious than if he had used it deliberately. S signed his name as a routine measure before being dismissed, thus writing was noted.

Foot preference was determined by pushing and by kicking. First, the adhesive roll was placed on the floor directly in front of S. Experimenter, E, stood with feet together, about 2 feet away from S. S was then told to push the roll until it touched E's feet. Next, the paper cone, large diameter down, was placed on the floor directly in front of S. E, standing,

TABLE 1

Correspondence of eye, hand, and foot preferences in children of normal and of defective vision

R., right preference. L., left preference

EYE	HAND	FOOT	NUMBER OF CASES	PERCENTAGE OF GROUP
I. Normal vision—200 cases				
R	R	R	169	84.5
L	L	L	4	2
R	R	L	0	0
L	L	R	3	1.5
L	R	R	15	7.5
R	L	L	2	1
R	L	R	0	0
L	R	L	0	0
Total correspondence			173	86.5
Correspondence of eye and hand, foot variant			3	1.5
Correspondence of hand and foot, eye variant			17	8.5
Correspondence of eye and foot, hand variant			0	0
Showing no definite dominance			7	3.5
II. Defective visual acuity—80 cases				
R	R	R	66	82.5
L	L	L	3	3.8
R	R	L	0	0
L	L	R	2	2.5
L	R	R	5	6.3
R	L	L	2	2.5
R	L	R	0	0
L	R	R	0	0
Total correspondence			69	86.3
Correspondence of eye and hand, foot variant			2	2.5
Correspondence of hand and foot, eye variant			7	8.8
Correspondence of eye and foot, hand variant			0	0
Showing no definite dominance			2	2.5

feet together, a distance between 7 and 8 feet in front of S, instructed S: "See if you can kick the cone to touch my feet."

result recorded, if same as the first. Where first and second results varied auxiliary means were taken to ascertain dominance of hand or foot in

TABLE 2

Correspondence of eye, hand, and foot preferences for children with varying degrees of defective visual acuity

EYE	HAND	FOOT	NUMBER OF CASES	PERCENTAGE OF GROUP
I. Defect same in both eyes—42 cases				
R	R	R	36	85.7
L	L	L	3	7.1
R	R	L	0	0
L	L	R	1	2.4
L	R	R	0	0
R	L	L	0	0
R	L	R	0	0
L	R	L	0	0
Total correspondence			39	92.8
Correspondence of eye and hand, foot variant			1	2.4
Correspondence of hand and foot, eye variant			0	0
Correspondence of eye and foot, hand variant			0	0
Showing no definite dominance			2	4.8
II. Defect greater in one eye—38 cases				
R	R	R	30	78.9
L	L	L	0	0
R	R	L	0	0
L	L	R	1	2.6
L	R	R	5	13.2
R	L	L	2	5.3
R	L	R	0	0
L	R	L	0	0
Total correspondence			30	78.9
Correspondence of eye and hand, foot variant			1	2.6
Correspondence of hand and foot, eye variant			7	18.5
Correspondence of eye and foot, hand variant			0	0
Showing no definite dominance			0	0

If S showed lack of correspondence between the tests and rechecks for handeness and footedness he was not questioned at the time, but at a later date was again tested and the second

general practice. In instances where S stated that he had been left handed but was trained to use right hand E regarded same as natively left handed if statement was verified by parent or

some older member of the family. Cases where lack of correspondence between tests and rechecks was evident were not included in table of correspondence. They are reported separately as *showing no definite dominance.*

Correspondence of eye, hand, and foot preference was shown in 86.5 per cent of the 200 cases having normal visual acuity (tables 1 and 2). In the 80 cases having defective visual acuity 86.25 per cent showed correspondence of eye, hand, and foot preference. In the 280 cases, or all of the cases studied, we find that 86.4 per cent show a correspondence of eye, hand, foot preference; 95 per cent a correspondence of hand and foot preference.

By making comparisons of 38 cases having normal visual acuity; 38 cases having defective visual acuity, the defect being the same in both eyes; and 38 cases having greater defect in one eye than in the other we find the total correspondence of eye, hand, and foot preference almost the same in the first two groups, 92.10 per cent, and 94.73 per cent; while the third group shows a total correspondence of only 78.94 per cent.

Parson (4) in his study on Left-handedness, came to the conclusion that in all except abnormal cases ocular dominance corresponds to the handedness of the individual. He pointed out that defective vision in the right eye caused left eyedness and vice-versa. In the present study, while a high correspondence of eye and hand dominance is shown, yet 8.5 per cent show a lack of correspondence in spite of normal visual acuity in both eyes. Furthermore, 9 cases having a greater visual defect in the right eye than in the left, were nevertheless right eyed; and one case having a greater visual defect in the left eye, was nevertheless left eyed. The degree of defect might be considered, yet here again we find exceptions, as one case having $\frac{20}{100}$ in the right eye and $\frac{20}{25}$ in the left eye, was right eyed. Since Parson tested vision only in the cases where eyedness and handedness did not correspond, the inferences drawn by him can scarcely be looked upon as conclusive. It is to be noted that in the present study the total correspondence of hand and foot (eye non-corresponding) is 8.5 per cent in the 200 cases, whereas no correspondence is found of eye and foot (hand non-corresponding) and only 1.5 per cent show correspondence of eye and hand (foot non-corresponding). In other words, there seems to be a much greater correspondence of *hand and foot* than of *eye* and *hand* or *eye* and *foot preference,* indicating that Parson's inference that eyedness determines handedness might be questioned.

Coons and Mathias (2) came to the conclusion that eye preference is not determined by relative visual acuity, but is determined by use and disuse, also that hand and eye preference tend to be homolateral. While the present study shows only a small difference in total non-correspondence between normal and defective visual acuity, it indicates that in cases where the visual defect is greater in one eye than in the other total correspondence is somewhat reduced.

Schott (5) found a correspondence of only 57 per cent in hand and foot preference of adult subjects whereas

the present study shows a correspondence of 95 per cent. To what factors one may attribute this discrepancy is difficult to say as the information on Schott's study is very meagre. It would seem, however, that the factor of training played a rather important part in Schott's test as foot preference was determined by noting which foot was used in starting off for a high jump; also it is assumed that his subjects were adults. We have as yet no assurance that starting off for a high jump constitutes dominance in that foot.

TABLE 3

Correspondence of handedness and footedness in children (from Bagley and Eyre)

	CASES	PERCENTAGE OF TOTAL
Correspondence of right hand and right foot...	55	70.5
Correspondence of left hand and left foot.....	17	21.8
Total correspondence of hand and foot....	72	92.3

A study by Bagley (1) on handedness and footedness of children at the Alhambra Play Ground gives results corresponding rather closely to those of the present study. The percentages of total correspondence are given in table 3. Handedness was determined by noting which hand the subject used to move the checkers in a game of checkers. Footedness was determined by having the subject try to kick a ball between the speed-ball goal posts.

SUMMARY AND CONCLUSIONS

Two hundred and eighty students were tested to ascertain what correspondence, if any, exists between eye, hand, and foot preference. Two hundred subjects had normal visual acuity ($\frac{20}{20}$ as tested by Snellen Chart) and 80 subjects had defective visual acuity in one or both eyes. The fixation test was used to determine ocular dominance, 98 subjects being rechecked with Parson's manoptoscope with no non-correspondence. Hand preference was determined by pointing and by writing. Foot preference was tested by noting which foot was used in pushing and in kicking.

The following conclusions may be drawn for this study:

1. There is a high correspondence of eye, hand, and foot preference in the human subject.

2. The correspondence of hand and foot preference is greater than the correspondence of eye and hand, or eye and foot preference.

3. Defective visual acuity, if defect is the same in both eyes, does not show an effect upon eyedness.

4. Where defective visual acuity is greater in one eye than in the other total correspondence of eye, hand, and foot preference tends to decrease.

Further investigation as to what constitutes foot dominance is being carried on through several studies now in progress at Claremont Colleges.

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An Application of the Descoeudres Performance Tests to Fifty-Seven American-Born Four- and Five-Year-Old Children[1]

DOROTHY E. BRADBURY

THE specific aim of this study was to investigate the achievement and the techniques used by four- and five-year-old children in solving certain performance tests adapted from Descoeudres, as shown by the time, number of correct placements, and errors. Information regarding the tests was obtained from Descoeudres' *Le Dévèloppement de l'Enfant de Deux à Sept Ans*, and Decroly and Monchamp's *L'Initiation a l'Activité*. The materials used by Miss Descoeudres comprising the 2 series of "jeux educatifs" in use at the Jean Jacques Rousseau Institute at Geneva, Switzerland were obtained.

The tests were first given to a few children as reported by Miss Descoeudres; later they were modified to suit the conditions revealed in the test situation.

The subjects were 57 four- and five-year-old children in daily attendance at the preschool laboratories of the Iowa Child Welfare Research Station. Forty-six were given the entire 6 series of tests. The children came from homes of various occupational levels with a majority of the professional class. The mean intelligence quotient of the subjects on the Stanford revision of the Binet test was 115.5 with a standard deviation of 10.1.

All the children were tested by the writer. The examiner started a stop watch when the directions were finished and stopped it when the child completed the test. If the child failed to understand the directions after the second repetition, the examiner demonstrated. The 6 series required 6 periods of testing for each child. Three scores were recorded for each test: time, number correct, and errors; each score was converted into T-scores.

MATERIALS AND PRESENTATION

Series I

Itard Color Lotto

Materials. The Itard Color Lotto consists of four large cards 5 by 7 inches and sixteen small cards 2½ by 3½ inches. Transverse lines divide the large cards into 4 parts. In each of the 16 divisions of the large card is an individual color block design of a familiar object. The 16 small cards have designs in the same colors.

Presentation. When the examiner placed the first little card in the child's hand, she said, glancing towards the large card, "Find a picture exactly like this one and put this small picture on top of it."

The child was given the cards in a random

[1] This study was directed at the Iowa Child Welfare Research Station by Dr. Beth L. Wellman.

order which was kept constant for all the children. The little cards placed by the child were left on the large cards.

The reliability of the test as determined by computing the correlation between the number correct on the first and the last two large cards and then stepped up by Brown's formula was .76 ±.04.

Itard Lotto

Materials. The materials for the Itard Lotto differed from the Itard Color Lotto in color only. The designs on both the small and large cards were in red.

Presentation. The presentation of the Itard Lotto was the same as that of Itard Color Lotto.

The small cards were given the child in a random order which was kept constant for all children. A correlation of .79 ±.02 was found between the number correct on the first two large cards and the last two cards and then stepped up by the Spearman-Brown formula.

Buttons

Materials. The Buttons test consists of 10 strips of pink flannel 2½ by 6½ inches; on 5 of which from one to five buttons are sewed, and on the other 5 from one to five buttonholes. The buttons are ⅝ inch in diameter and the buttonholes ⅝ inch in length.

Presentation. The examiner placed the one-button strip on the child's left and the one-buttonhole strip on his right. Holding up the former she said, "See this button?" then, picking up the buttonhole strip, "And this buttonhole? They are buttoned like this." After fastening and unfastening the strips they were then handed to the child, the examiner saying, "Now you button them."

After the child buttoned the one-button strip, the examiner presented the two-button and two-buttonhole strips saying, "Let's see you button these." Then the other strips were presented in order.

Series II

Star Matching Game

Materials. This test differs from the Itard Color Lotto in the designs; only one design, the star, occurs in this lotto. The colors are the same as in the Itard Color Lotto.

Presentation. The presentation was the same as that of the Itard Color Lotto and the Itard Lotto except the word "star"was substituted in the directions for "picture." A random order was used in giving the child the small cards; this order was kept constant for all children. The small cards placed by the child were left on the large cards.

The reliability of the test determined as for the Itard Color Matching Game was .59 ± .06.

Tint Lotto

Materials. The Tint Lotto consists of 4 large cards 2½ by 6¾ inches and 16 small cards 1½ by 2½ inches. Three straight vertical lines divide the large cards into fourths. In each of the divisions is an individual color tint block design of a flag. The small cards have flags in the same color and tint.

Presentation. The large cards were placed on the table in front of the child, the large card with green flags at the top, the card with the red flags next, then the card with the yellow flags, and at the bottom the card with the blue flags. The directions were the same as that used in the Itard Color Lotto except that the word "flag" was substituted for the word "picture."

The children were given the flags in a random but constant order. The small cards placed by the child were left on the large cards. When the scores on the first 2 large cards were correlated with the last 2 large cards and the Spearman-Brown formula used the reliability was .51 ±.03.

Man with a Ball Lotto

Materials. Two large cards 5 by 7 inches and 8 small cards 2½ by 3½ inches compose the Man with a Ball Lotto. The large cards are divided into 4 equal parts by transverse lines. In each of the divisions is an individual color block design of a man tossing a ball, the ball differing in color from that of the man. The 8 small cards have designs in the same colors.

Presentation. The large cards were

placed on the table before the child. The directions were the same as that used in the Itard Color Lotto. The cards were given in a random order. The examiner removed the small cards as the child placed them.

A reliability of .71 ±.05 was found for the test when the correlation between the number correct on the first and last large card was stepped up by the Spearman-Brown formula.

Boy of Three Colors

Materials. The dimensions of the cards composing the Boy of Three Colors Lotto are the same as those of the Man with a Ball Lotto. There is a drawing of a little boy in each of the divisions of the large cards. The cap of each boy is of one color, the blouse of another, and the trousers and stockings of a third. There are duplicate boys on the 8 small cards.

Presentation. The examiner placed the large cards on the table before the child, then placed the small cards in the child's right hand, one at a time.

When the child was given the first small card the examiner said, glancing or pointing toward the large cards, "Find a little boy exactly like this one and put this little boy on top of it."

The child was given the cards in a random order which was kept constant throughout the experiment. The small cards were removed as the child placed them.

The reliability of the test was .71 ±.05.

Series III

Girl with the Big Umbrella Lotto

Materials. The Girl with the Big Umbrella Lotto is similar to the Boy of Three Colors Lotto. In each of the divisions of the large cards is a drawing of a little girl carrying a big umbrella. Each girl has an umbrella of one color, a cap of another, and a raincoat and stockings of another color. The 8 small cards have duplicate girls.

Presentation. The presentation was the same as the Boy of Three Colors except the word "girl" was substituted for "boy" in the directions.

The child was given the cards in a random order; the same order, however, was used with all the children. The examiner removed the small cards as the child placed them.

The correlation of reliability was .68 ±.04.

Wooden Shoe Lotto

Materials. Two large cards 7 by 5 inches and 24 small cards 2½ by 1½ inches are included in the Wooden Shoe Lotto. The large cards are divided into 12 parts by transverse lines. In each of the 24 divisions is a color block design of a wooden shoe; 12 shoes in individual color pointing to the right and 12 in duplicate colors to the left. The small cards have corresponding designs.

Presentation. After putting the 2 large cards on the table before the child, the examiner placed a small card in each of the child's hands. Care was taken to place the card with the shoe pointing to the right in the child's left hand and the shoe pointing to the left in his right hand. On giving the first two cards to the child the examiner said, "Here are two shoes that are not alike. You are to place each shoe on one exactly like it."

The child was given the small cards, 2 of the same color at a time, in a random order. The small cards placed by the child were left on the 2 large cards.

The reliability of the test was .68 ±.02.

Flag and Key Lotto

Materials. The Flag and Key Lotto consists of 2 large cards 5 by 7 inches with 8 small cards 2½ by 3½ inches. The large cards are divided into 4 equal parts by transverse lines. In each division of one large card is an individual color block design of a green flag; in each of the divisions of the other large card, an individual color block design of a red key. The small cars have the same designs in the same color.

Presentation. The 2 large cards were spread on the table before the child; otherwise the presentation was the same as used in the Itard Color Lotto. The child was given the small cards in a random order, but

the same order was used with all subjects. The small cards placed by the child were left on the large cards.

The reliability of the test was .46 ±.03.

Scissors

Materials. The Scissors Lotto consists of 3 large cards 4¾ by 5 inches and 9 small cards: three, 2 by 5 inches, three, 1½ by 5 inches, and three, 1¼ by 5 inches. On each of the large cards are 3 drawings of scissors, varying in size. The colors of the drawings vary from large card to large card but are constant on the same card. The 9 small cards have drawings in the same colors.

Presentation. After the 3 large cards were placed on the table before the child, the examiner placed the small ones in the child's hand one at a time. When the examiner placed the first small card in the child's hand she said, glancing or pointing toward the large card, "Find some scissors exactly like these and put these on top of it."

The child was given the cards in a random order. The small cards placed by the child were left on the large cards.

The reliability of this test was .35 ±.10.

Series IV

Bottles

Materials. The Bottles Lotto is similar to the Scissors Lotto. On each of the large cards are 3 drawings of bottles, varying in size. The colors differ from large card to large card but are constant on the same card. The 9 small cards have drawings in the same colors.

Presentation. The presentation was the same as for Scissors Lotto except the word "bottle" was substituted for "scissors" in the directions.

The correlation of the Bottles and Scissors Lotto was .55 ±.04.

Bodily Position Lotto

Materials. The Bodily Position Lotto consists of 2 large cards 5 by 7 inches and 8 small cards 2½ by 3½ inches. The large cards are divided into 4 parts by transverse lines; in each of the 8 divisions are individual block designs of blue toy men. The 8 small cards have corresponding designs.

Presentation. The presentation was the same as for the Flag and Key Lotto. The child was given the small cards in a random order; this order was the same for all the children. The small cards placed by the child were removed from the large cards by the examiner as soon as placed.

The reliability coefficient as determined by correlating the number correct on one card with the number correct on the other card, and stepping the correlation up by the Spearman-Brown formula was .72 ±.04.

Ball on the Table Lotto

Materials. The Ball on the Table Lotto consists of 2 large cards 7 by 5 inches and 8 small cards 3½ by 2 inches. Transverse lines divide the large cards into 4 parts, each of which have a drawing in perspective of a table, on or near which there is a small ball (mm. in diameter). The 8 small cards have corresponding drawings.

Presentation. With the two large cards on the table before the child, the examiner placed the small cards in the child's right hand one at a time. When the examiner placed the first small card in the child's hand, she said, "Do you see this ball on this table? You are to find another ball and table exactly like this one."

The child was given the cards in a random order which was kept the same for all the children. The reliability of the tests was .76 ±.04.

Domino of Tints

Materials. The Domino of Tints is composed of 16 small cards 2¼ by 1⅛ inches. Each small card is divided into two parts, one half being a tint of one color and the other half being a tint of the same color, or, in a case of four connecting cards, of an entirely different color. There are 2 small cards having halves of the same tint and color.

Presentation. The small cards were spread in random order before the child. The examiner took 2 small cards (one with a very light green and light green halves; the other with light green and medium green

halves) saying, "This is a little sidewalk game. We are going to build a little sidewalk. Do you see these two little cards? This half of this card" (pointing) "is exactly like this half of this card" (pointing). "You put the halves that are alike together like this" (joining the two cards). "Now, you find a half of a little card that is exactly like the other half of this little card! That's good. Now do the others in the same way."

The reliability of the test as determined by correlating the number correct on one-half the test and then stepping it up by the Spearman-Brown formula was .52 ±.02.

Series V

Geometric Figures Form Board I

To one-half of the children Geometric Figures Form Board I was presented as the first test in this series; to the other half, Geometric Figures Form Board II was presented. (See Series VI.)

Materials. The Geometric Figures Form Board I consists of 5 boards 13¾ inches by 5 inches by ¼ inch. Appearing on each of the 5 boards are 5 different holes for such geometric figures as a circle, square, triangle, and rectangle. A block fits into each one of these holes.

On the first board are holes for 5 rectangles of varying sizes arranged in order of size; on the second, 5 circles; on the third, 5 squares; and on the fourth, 5 equilateral triangles. The fifth board is made up of the largest figures appearing on the 4 previous boards including holes for a rectangle, a square, a circle, and a triangle.

Presentation. The 5 form boards were placed before the child one at a time in the order described above. The blocks fitting into the boards were placed on the table in a random order above the board.

The examiner said, pointing to the blocks above the board, "You are to put these blocks into these holes" (pointing to the holes in the board) "as quickly as you can." If the child failed to comprehend the directions, they were repeated. If the child still did not understand, the examiner demonstrated by placing one block and then returning it to the tray.

Bead Stringing

Materials. The Bead Stringing test uses 11 red beads 3½ inches in circumference, a red string 25 inches long, and an embroidery needle 2 inches in length with a blunted point. One bead is fastened at the end of the string. The hole in the beads is $\frac{3}{16}$ inch in diameter.

Presentation. The beads were in a tray before the child. The string with the bead knotted in the end was at the right of the tray. The examiner pointed to the string and said, "Do you see this string and these beads?" (pointing to the beads) "You are to string the beads as quickly as you can."

Set Table Lotto

Materials. Two large cards 5 by 7 inches divided into four parts by transverse lines and 8 small cards 2½ by 3½ inches compose the Set Table Lotto. In each of the 8 divisions is a drawing of a table with dishes on it. There are always 4 dishes but never the same four. The 8 small cards have corresponding drawings.

Presentation. The 2 large cards were placed on the table in front of the child. The examiner placed the small cards in the child's right hand one at a time. Glancing or pointing toward the large card the examiner said, "These tables are all set for dinner. Each table has a different kind of dishes. Find a table with the same kind of dishes as this one."

The child was given the small cards in a random order which was kept constant for all children. The small cards placed by the child were removed by the examiner as they were placed. The correlation coefficient of the number correct on the first and second large card when stepped up by the Spearman-Brown formula was .79 ±.02.

Series VI

Geometric Figures Form Board II

(Given to one-half of the children in Series V.)

Materials. The material used for Geometric Figures Form Board II is the first four boards of Geometric Figures Form Board I.

Presentation. The 4 form boards containing the spaces for the 5 rectangles, circles, squares, and triangles were placed in front of the child. The blocks fitting into the spaces were placed at the right side of the boards in random order. The examiner said, pointing to the blocks, "You are to put these blocks into these holes."

Stair Steps

Materials. The Stair Steps test consists of 5 pairs of wooden blocks, the same shape and size but varying in thickness. The 2 largest blocks are 3 by 2⅛ by 2½ inches, the next 2 blocks 3 by 2⅛ by 2 inches, the next 2 are 3 by 2⅛ by 1 inch, and the 2 smallest blocks 3 by 2⅛ by ½ inches.

Presentation. The blocks were in a pile at the child's right in a random order. The examiner took one set of 5 blocks and built a series of stair steps. When they were finished she said, glancing or pointing at the stair steps, "Do you see these steps? Make some exactly like them."

Number Lotto

Materials. There are 6 large cards 8 by 6 inches and 36 small cards 4 by 3 inches in the Number Lotto. The large cards are divided into 4 parts by transverse lines. In each of the 36 divisions are from one to six small objects. The 36 small cards have a corresponding number of objects.

Presentation. The first and second large cards with one and two objects were placed on the table before the child in a right to left order, then the second and third, the fourth and third, the fourth and fifth, the sixth and fifth. As the examiner placed a small card in each hand of the child (the card to be placed on the right card in the left hand and vice versa), she said, glancing or pointing toward the large cards, "Find a card with the same number of buttons as this one and put this card on top of it."

The small cards for each pair of large cards were given the child in a random order that was kept constant for all the children.

ANALYSIS OF RESULTS

Relation between time, number correct, and errors. In tables 1, 2, 3, 4, and 5, the arithmetic mean and standard deviation for each test are shown for both age groups. In general, the time required in performance and the number of errors made decrease with increasing age; the number of correct performances increase. The differences between the 2 age groups are statistically significant for the majority of the test items. For some tests the differences in time were not significant from a statistical analysis. Analysis of the performances shows that the five-year-olds often placed a greater number of cards and made fewer errors, requiring a longer time for the increased placements. It also appears that the five-year-olds have a clearer concept of differences in designs, the perception of which is essential to success, and consume more time in consideration of these differences. The greater number of correct placements with a decrease in errors gives evidence of the importance of the attention to differences in detail.

TABLE 2

Time in seconds—Buttons Test

STRIP	4 YEARS			5 YEARS		
	Children	Mean	S.D.	Children	Mean	S.D.
1	28	18.1	13.7	29	9.8	3.9
2	28	52.7	39.3	29	23.0	10.7
3	28	86.6	55.0	29	35.1	16.6
4	28	112.4	73.3	29	46.3	17.7
5	28	117.5	68.1	29	53.7	17.7

For certain tests time is not a good measure of performance. One test item, the Domino of Tints, showed a reversal in performance, the younger group being more accurate but requiring longer time. The differences in

TABLE 1

Means and standard deviations of time in seconds, number of correct placements and number of errors by age groups on Itard Color Lotto, Itard Lotto, Star Matching Game, Tint Lotto, Man with Ball Lotto, Boy of Three Colors, Girl with the Big Umbrella Lotto, Wooden Shoe Lotto, Flag and Key Lotto, and Scissors

AGE	CHILDREN	TIME		NUMBER CORRECT		ERRORS	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
			Itard Color Lotto				
years							
4	29	150.2	59.8	14.0	3.5	2.3	4.5
5	28	101.9	31.5	16.0	0.0	0.3	0.2
			Itard Lotto				
4	29	146.6	48.3	13.7	4.1	2.7	4.4
5	28	87.6	20.5	15.9	0.2	0.1	0.3
			Star Matching Game				
4	25	163.0	86.1	10.0	2.8	5.9	2.8
5	29	136.7	56.4	14.3	2.5	2.2	2.5
			Tint Lotto				
4	25	170.0	63.3	6.8	3.2	9.8	2.7
5	29	164.2	63.9	10.9	3.9	6.1	4.1
			Man With a Ball Lotto				
4	25	85.8	40.8	4.5	1.9	3.6	1.9
5	29	84.8	32.4	7.6	1.6	2.0	1.9
			Boy of Three Colors				
4	25	87.6	37.2	3.5	1.6	5.7	2.9
5	29	92.2	44.5	5.9	2.0	2.2	1.9
			Girl With the Big Umbrella Lotto				
4	20	97.3	36.5	5.0	2.3	3.3	2.3
5	25	104.2	40.4	5.9	1.4	2.0	1.7
			Wooden Shoe Lotto				
4	20	203.1	105.1	9.9	4.3	14.2	3.5
5	25	276.1	86.9	15.2	7.2	8.9	7.5
			Flag and Key Lotto				
4	20	57.9	11.8	2.4	1.5	6.0	1.4
5	25	74.8	29.2	4.0	2.2	4.1	2.1
			Scissors				
4	20	68.2	20.9	6.4	2.1	3.1	1.9
5	25	72.1	26.0	7.3	1.9	2.0	2.1

accuracy were slight and are statistically unreliable. Many children in both groups failed to understand what was wanted. Another test item, stair steps, was too simple for both age groups. No real differences in performance were found.

In general, low negative or positive correlations are found between number correct and time. Though the groups are small for use of the correlation method the indication is that there is little relationship between time and the accuracy of a child's performance. In three instances a fairly substantial negative relationship indicates that the children who took greater amounts of time tended to get fewer correct on these tests.

The correlations between number correct and errors are negative and high indicating that children who

TABLE 3

Means and standard deviations of time in seconds, number of correct placements and number of errors by age groups in Bottles, Bodily Position Lotto, Ball on the Table Lotto, Domino of Tints, Geometric Figures Form Board II, Set Table Lotto, and Stair Steps

AGE	CHILDREN	TIME		NUMBER CORRECT		ERRORS	
		Mean	S.D.	Mean	S.D.	Mean	S.D
Bottles							
years							
4	20	70.0	11.0	8.1	0.9	1.0	1.7
5	22	62.1	19.5	8.2	1.0	0.9	1.1
Bodily Position Lotto							
4	20	76.2	22.1	2.7	2.7	6.3	2.0
5	22	78.2	29.7	5.3	2.3	3.7	2.1
Ball on the Table Lotto							
4	20	79.6	19.1	3.4	2.1	5.8	2.0
5	22	74.2	19.2	5.7	2.9	3.3	2.4
Domino of Tints							
4	20	214.1	45.8	9.8	4.3	6.8	4.8
5	22	198.2	60.7	9.0	4.5	7.3	6.4
Geometric Figures Form Board II							
4	14	160.0	76.2	2.0	0.0	3.7	1.7
5	26	112.2	27.4	2.0	0.0	2.1	2.0
Set Table Lotto							
4	14	104.1	46.4	3.5	1.6	4.6	1.7
5	23	96.4	15.5	4.7	2.5	3.8	2.2
Stair Steps							
4	11	52.3	26.4	5.0	0.0	1.8	1.8
5	28	48.5	29.1	2.7	0.9	1.3	2.7

placed the cards correctly tended to make few errors. Exceptions to this finding for 2 test items are seemingly explained by other factors. The Ball on the Table Lotto was difficult for many children and many trials were made before placements were made. The Man with a Ball Lotto required perception of small differences and some children apparently matched on the basis of the color of one object rather than of two. A child who took

TABLE 4

Means and standard deviations of time in seconds, number of correct placements and number of errors by age groups on Geometric Figures Form Board I

BOARD	CHILDREN	TIME		NUMBER CORRECT		ERRORS	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
4 Years							
Rectangles	13	41.5	7.5	5.0	0.0	2.30	1.20
Circles	13	31.4	16.4	5.0	0.0	0.58	0.72
Squares	13	51.7	16.1	5.0	0.0	1.80	0.67
Triangles	13	61.2	24.9	5.0	0.0	2.00	1.50
Composite	13	36.6	12.0	4.0	0.0	0.83	0.80
5 Years							
Rectangles	26	39.4	15.8	5.0	0.0	1.40	1.40
Circles	26	21.5	10.4	5.0	0.0	0.31	0.96
Squares	26	48.6	28.1	5.0	0.0	1.20	1.40
Triangles	26	45.5	26.0	5.0	0.0	1.40	1.40
Composite	26	29.8	11.5	4.0	0.0	0.84	0.80

TABLE 5

Means and standard deviations of time in seconds, number of correct placements and number of errors by age groups on Number Concept

PRESENTATION	CHILDREN	TIME		NUMBER CORRECT		ERRORS	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
4 Years							
I	11	43.6	19.4	7.81	0.62	0.18	0.57
II	11	37.1	29.8	7.63	1.30	0.34	1.10
III	11	46.7	14.9	6.00	1.40	2.00	1.20
IV	11	54.0	11.6	5.30	1.90	2.90	2.00
V	11	61.5	25.1	4.40	2.70	3.60	1.40
5 Years							
I	28	38.1	14.2	8.00	0.00	0.00	0.00
II	28	38.8	14.7	8.00	0.00	0.00	0.00
III	28	38.3	15.2	6.70	1.50	1.20	1.70
IV	28	47.7	23.7	5.90	2.10	5.50	2.00
V	28	48.6	31.8	6.10	2.30	1.10	2.10

both into account, although eventually getting more correct, also made more errors.

CORRELATION BETWEEN EACH TEST AND THE COMPOSITE T-SCORES FOR ENTIRE SIX SERIES

Correlations ranging from .19 ±.11 to .73 ±.05 are found when the composite score on each test (average T-score of time, number correct, and errors) is correlated with the composite score of the entire series (average T-score of the children on the twenty tests). These correlations are given below:

Boy of Three Colors	.73 ±.05
Flag and Key Lotto	.65 ±.08
Bodily Position Lotto	.63 ±.07
Wooden Shoe Lotto	.62 ±.06
Man with a Ball Lotto	.57 ±.08
Buttons	.55 ±.07
Star Matching Game	.52 ±.08
Itard Color Lotto	.52 ±.08
Itard Lotto	.50 ±.08
Tint Matching Game	.50 ±.08
Bead Stringing	.49 ±.08
Scissors	.49 ±.09
Stair Steps	.44 ±.09
Number Concept	.42 ±.09
Domino of Tints	.42 ±.09
Geometric Figures Form Board I	.40 ±.09
Bottles	.34 ±.10
Girl with the Big Umbrella	.26 ±.08
Set Table Lotto	.25 ±.03
Geometric Figures Form Board II	.19 ±.11

RELATION OF ALL SERIES TO STANFORD-BINET TESTS

The relationship between mental age on the Stanford-Binet and the composite T-scores based on all the tests is .56 ±.08. The relatively low relationship would indicate that this series does not measure to any great degree the abilities measured by the Stanford-Binet.

SUMMARY AND CONCLUSIONS

The objective of this study was to study time, number of correct placements, number of errors, and the techniques used by four- and five-year-old children in solving certain performance tests adapted from Descoeudres. The subjects were 29 four-year-old and 28 five-year-old children in daily attendance at the preschool laboratories of the Iowa Child Welfare Research Station. Thirty-six of these children were given the 6 series of tests.

The materials and methods as described in this study are well adapted for the study of four- and five-year-old children. In addition to an analysis of the performance on the tests themselves a study was made of the techniques used by the children in solving the tests.

The specific findings of this study are:

1. In general, the mean number of correct placements increases with age and the mean time and errors decrease with age on these tests.

2. The correlations between the individual tests and the composite T-scores based on twenty tests ranged from .19 to .73.

3. In general, time does not seem a good measure of the accuracy of a child's performance.

4. In certain tests, number of correct placements seems to be a better index of performance in light of the ratio of the difference between the means and the standard deviation of

the difference and the correlations between time, score, and errors.

5. The best unit to be used in scoring a test can only be determined by a study of the time, number correct, and error scores of the test.

6. The relationship between mental age on the Stanford-Binet and the composite T-score based on all the tests was .56 ±.08.

7. The reliabilities of the various tests ranged from .81 ±.03 to .35 ±.10.

Brief Report

The Maturational Factor in Adolescent Conduct

RECENT research in child psychology has tended to throw into relief the concept of maturation. It is now realized that conduct at a given age level is not simply the product of learning, acting on certain innate reaction patterns. Quite new forms of behavior and quite new powers appear at intervals. These changes are presumably due to the gradual maturation of the nervous system. At least, the classical work of Tilney and Casamajor (10) has made that conclusion probable. Gesell and his pupils (5) have shown the importance of maturation in the acquisition of speech and certain motor habits, while Shirley (8, 9) has demonstrated that the process of learning to walk is part of a general "motor sequence" with a maturational basis.

Besides this neural maturation, we must recognize another sort of maturation due to hormones; for it is generally agreed that the characteristic behavior changes of adolescence are to be so explained. There has, however, been little effort to test this connection under scientific control. To do so is the object of this paper.

To demonstrate the relationship between the presence of the sex hormone in the blood stream on the one hand and an adolescent maturity of conduct on the other, measures of both these variables must be at hand. In the present investigation, the "Scale for Measuring Developmental Age in Boys" published by one of the present writers (4) was used to determine maturity of conduct. Developmental Age (DA) denotes a maturity which shows itself in changing play preferences, a changing attitude toward authority, a changing interest in the other sex, and, in general, in a more "adult" type of conduct. Previous studies (3, 4) have shown that DA is not appreciably related to general intelligence, if age is held constant.

The measurement of the degree of physical adolescence is more difficult. The following possibilities suggest themselves:

1. The most satisfactory method would be to measure directly the amount of the sex hormone present in the subjects' blood. Unfortunately, no practically feasible technique for this measurement is at present known.

2. A second possibility would be to compare the Developmental Quotients (DQ's) of a group of preadolescents and a group of adolescents, age being held constant. Some preliminary work has been done by the present writers along this line. A number of boys living under rather uniform conditions in a large home for dependent children were rated by Crampton's (1) norms. Those pubescent or postpubescent by these norms were classi-

fied as *adolescent*; those prepubescent by the above standards were classified as *preadolescent*. All cases were selected between the chronological ages of 168 and 180 months, both inclusive. This represents a range of approximately six months in either direction from the average age of the occurrence of puberty. The mean DQ of the ten preadoleacent boys within this range was 79.1; the mean DQ of the fourteen adolescent boys was 90.8. The difference in maturity is interesting, although, of course, the group was too small to permit definite conclusions.

3. The method of the last paragraph has the disadvantage that it classes all adolescents together and does not allow for different degrees of physical maturity within the adolescent group. A third method which overcomes this objection to some extent would be to correlate DA scores with secondary sex characteristics on the assumption that the latter are roughly representative of adolescent physical maturity. Physical measurements are the most convenient quantities to use in this connection, since they are readily obtainable and since increased physical growth is generally considered an important secondary characteristic of adolescence. This was the method used in the present study.

Previous work by Zalduondo (12) and by one of the present writers (4) has shown that DA is not correlated with physical measurement in younger boys, but that correlations between DA and weight and height appear in older boys. The present study investigates the rôle of adolescence in this respect. The subjects were 113 boys selected at random from the large home for dependents already mentioned. It was felt that the uniformity of environment offered by an institution would eliminate various sources of error which might be present if the subjects were taken from the various environments of their own private homes.

The following physical measures were used:

1. Length of leg, measured from the floor to the anterior superior spine of the ilium.

TABLE 1

Partial correlations of developmental age and specified physical measurements

(C.A. constant)

CORRELATION	PREADOLESCENTS	ADOLESCENTS	D/σD
DA and leg length....	0.12	0.22	0.52
DA and shoulder width.	−0.05	0.37	2.36
DA and width of hips.	−0.13	0.36	2.77
DA and span.....	0.21	0.60	2.59
DA and trunk length..	−0.03	0.25	1.44
Mean.....	0.02	0.36	2.64

2. Width of shoulders, the distance between the acromion of each shoulder.

3. Maximum width of hips.

4. Span, the maximum distance between the tips of the fingers of the outstretched hands.

5. Length of trunk. This measure was not made directly but was obtained by subtracting the length of leg from the shoulder height. All measurements were made without clothing.

The partial correlations (chronological age constant) between DA and each of these measurements is shown in table 1 separately for the preado-

lescent and the adolescent group. It will be noted that the coefficients for the former group differ from zero only as they might be expected to differ by chance. For the latter group, however, the relationship seems to be significant, though small.

The last column gives the quantity $D/\sigma D$. This was calculated by Kelley's (7) formula 140. In calculating this quantity for the means of the correlations, Yule's (11) formula for the correlation of sums was used. This latter formula involved the use of correlations between coefficients of correlation. These were obtained by Filon and Pearson's (2) method. It will be seen that the differences in question are, in general, fairly significant.

It is axiomatic that positive correlations do not define the causal relationship between the variables concerned. Either variable may be the cause of the other or they may have a common cause. In the present case DA might conceivably be the cause of the physical growth, or physical growth might cause DA, or they might be due to a common cause.

It seems hardly plausible that maturity of conduct should cause physical growth. It is possible, however, that physical growth might inspire greater maturity of conduct, a larger boy feeling himself bound to behave in a more mature manner, becoming his size. If this is the case, however, it is hard to understand why this relationship should appear suddenly at adolescence.

There remains, therefore, the possibility that both increased DA and increased growth are due to a common cause and it seems reasonable to suppose that this common cause is the presence of the sex hormone in the blood stream. It is known that this hormone is responsible for the rapid growth at adolescence. We can scarcely escape the conclusion, therefore, that the maturity of conduct which is shown to be related to it, is due to the same cause.

SUMMARY AND CONCLUSIONS

1. A small but constant and significant relationship between Developmental Age and physical measurement was demonstrated in a group of 43 adolescent boys.

2. No such relationship was discoverable in a group of 70 preadolescent boys.

3. The data suggest that the characteristic adolescent maturity of conduct is actually due to the presence of the sex hormone. Adolescent behavior is therefore another example of "maturational" behavior.

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